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Water Quality Studies of the Spokane River between Coeur D'Alene, Idaho and Post Falls, Idaho 1978-1979

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THIS REPORT DESCRIBES A PROGRAM DESIGNED TO COLLECT DATA NECESSARY TO ESTIMATE THE IMPACT OF WASTE DISCHARGE FROM THE SEWAGE TREATMENT PLANT AT COEUR D'ALENE INTO THE SPOKANE RIVER BETWEEN LAKE COEUR D'ALENE AND POST FALLS, IDAHO.

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WATER QUALITY STUDIES OF THE SPOKANE RIVER BETWEEN COEUR D'ALENE, IDAHO AND POST FALLS, IDAHO 1978 - 1979

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INTRODUCTION

The Spokane River between the outlet of Lake Coeur d'Alene and Post Falls Dam in Idaho (Figure 1) is a multi-purpose reservoir providing recreation, irrigation, navigation and hydroelectric power generation benefits. Studies by the U.S. Geological Survey (USGS) (Drost and Seitz(1978)) suggest that this segment of the Spokane River contributes an average of 150 c.f.s. to the Rathdrum Prairie Aquifer, an important source of water supply for the Spokane Valley. The river segment also serves as the receiving water of the effluent from the City of Coeur d'Alene's sewage treatment plant.

Due to population growth, both Post Falls and Coeur d'Alene are increasing the sizes of their waste treatment facilities. In order to design these facilities so that the water quality of the Spokane River is maintained, it is necessary to estimate the maximum level of waste discharge consistent with this goal. A proper estimate of this level requires substantial study of the river system. This report describes a program of study conducted by Environmental Protection Agency, Region 10, designed to collect data necessary to estimate the impact of waste discharge upon dissolved oxygen under summer low-flow conditions. Field measurements of certain nutrient levels in the treatment plant and the receiving water, algal assays and a reconnaissance survey of aquatic plants were adjunct observations which may prove helpful in determining the effect future discharges will have on the trophic status of the river segment.

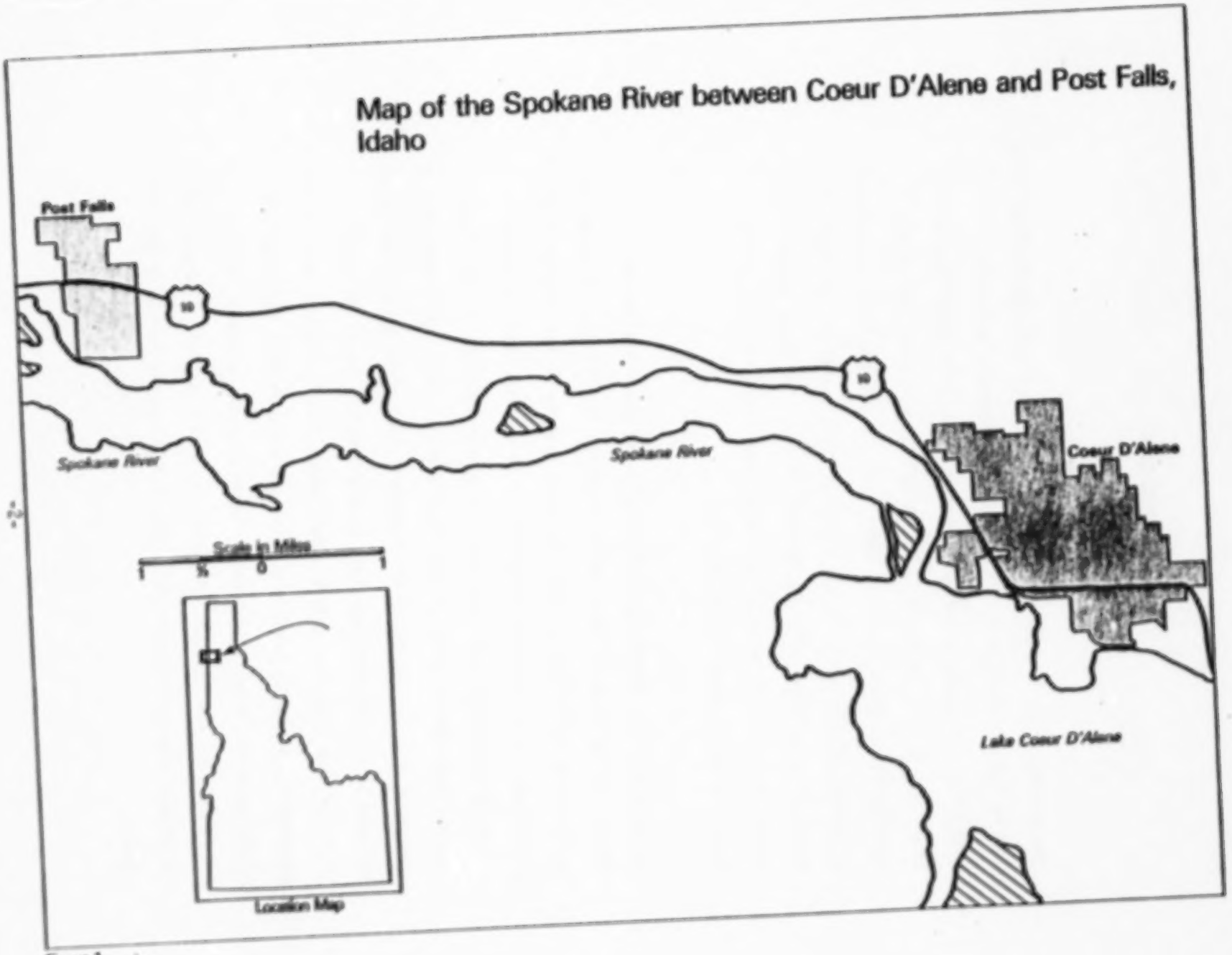

Map of the Spokane River between Coeur D'Alene and Post Falls, Idaho
Post Falls
Spokane River
Spokane River
Coeur D'Alene
Lake Coeur D'Alene
Scale in Miles
Location Map

Figure 1

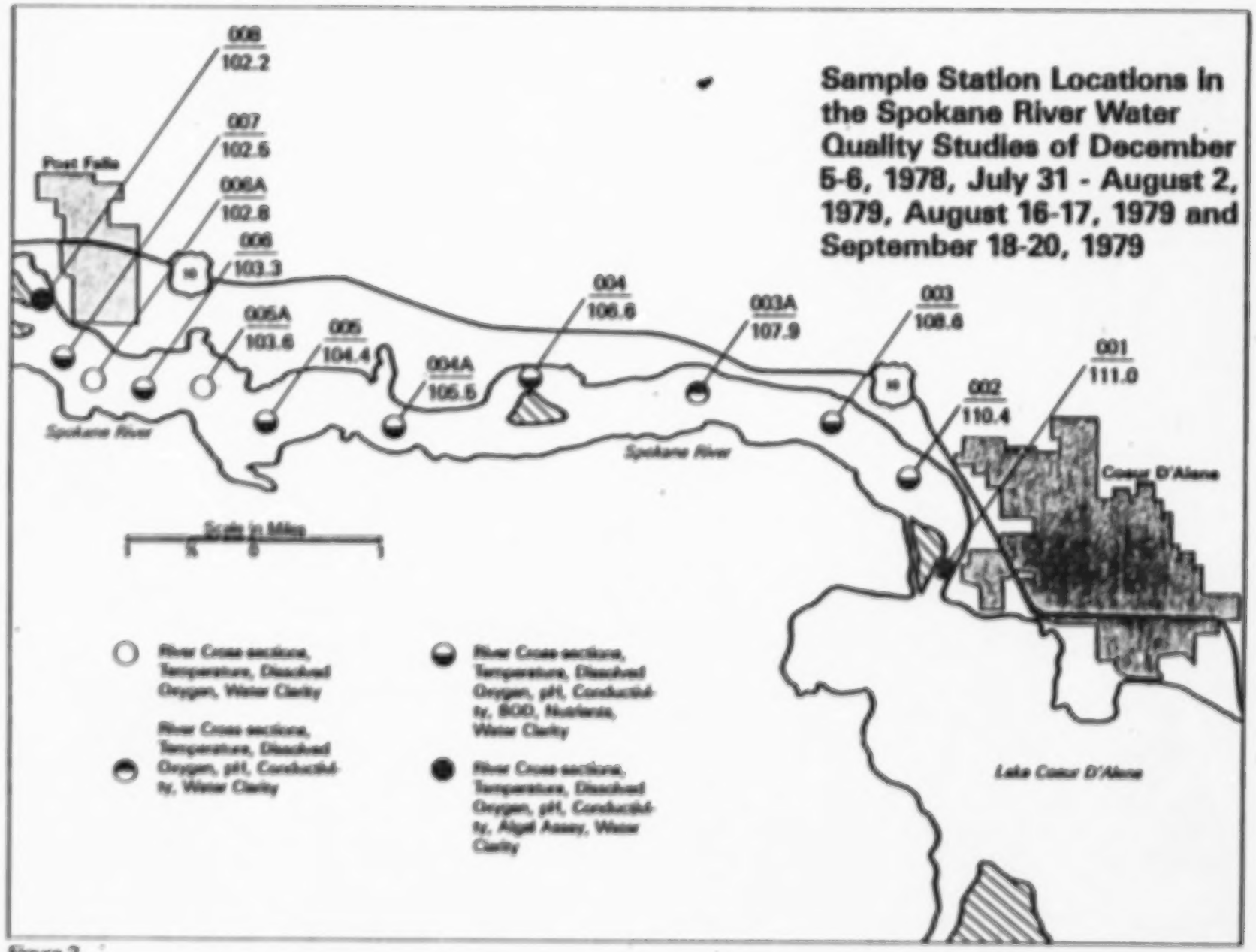

Sample Station Locations in the Spokane River Water Quality Studies of December 5-6, 1978, July 31 - August 2, 1979, August 16-17, 1979 and September 18-20, 1979
008
102.2
007
102.5
006A
102.8
006
103.3
005A
103.6
005
104.4
004A
105.5
004
106.6
003A
107.9
003
108.6
002
110.4
001
111.0
Post Falls
Spokane River
Spokane River
Coeur D'Alene
Lake Coeur D'Alene
Scale in Miles
River Cross-sections, Temperature, Dissolved Oxygen, Water Clarity
River Cross-sections, Temperature, Dissolved Oxygen, pH, Conductivity, Water Clarity
River Cross-sections, Temperature, Dissolved Oxygen, pH, Conductivity, BOD, Nutrients, Water Clarity
River Cross-sections, Temperature, Dissolved Oxygen, pH, Conductivity, Algal Assay, Water Clarity

Figure 2

FIELD STUDIES

The field study program included four surveys of this segment of the Spokane River. Table 1 shows the survey dates and the type of information collected during each survey.

Table 1 Dates of field studies on the Spokane River between Coeur d'Alene and Post Falls, and type of information collected

Survey	Date	Type of Information
I	December 5-6, 1978	River cross-sections, temperature, dissolved oxygen, water clarity
II	July 31-August 2, 1979	Temperature, dissolved oxygen, pH, conductivity, BOD, phosphorus, nitrogen, water clarity
III	August 16-17, 1979	Temperature, dissolved oxygen, pH, conductivity, water clarity
IV	September 18-20, 1979	Temperature, dissolved oxygen, pH, conductivity, BOD, phosphorus, nitrogen, algal assay, aquatic plant survey, water clarity

Methods

The sampling program included observations which we made in the field, as well as measurements made from samples shipped to the EPA Regional Laboratory at Manchester, Washington. Table 2 shows the measurements we made in the field and the type of instruments used.

Table 2 Methods used to obtain measurements in the field during Surveys I-IV on the Spokane River between Coeur d'Alene and Post Falls

Measurement	Method
Temperature	Thermistor*, mercury thermometer
Dissolved oxygen	Polarographic electrode*, Winkler (azide modification)
pH	Electrode*
Conductivity	Electrode*
Water clarity	Secchi disk
River cross-sections	Recording fathometer

* Module of Hydrolab Surveyor Model 6D

Those samples for which measurements were made at the laboratory, were stored in polyethylene containers, packed in ice and shipped via air freight. For those measurements made in the laboratory, the method is shown in Table 3 and described by EPA's (1979) Methods for Chemical Analysis. Location of sampling stations and type of measurement at each station are shown in Figure 2.

Table 3 Methods (EPA (1979)) used for those samples shipped to the EPA Region 10 Laboratory during Surveys II and IV on the Spokane River between Coeur d'Alene and Post Falls

Parameter	Method
5-day BOD	5-day -20°C incubation
10-day BOD	10-day -20°C incubation
15-day BOD	15-day -20°C incubation
20-day BOD	20-day -20°C incubation
Ammonia-nitrogen	Auto Analyzer II
Nitrite+nitrate-nitrogen	Auto Analyzer II
Total Kjeldahl nitrogen	Block digestion + Auto Analyzer II
Total phosphorus	Block digestion + Auto Analyzer II
Dissolved orthophosphate	Auto Analyzer II
Total organic carbon	Combustion or oxidation

RESULTS

Receiving Waters

Cross-Sectional Characteristics

Transverse profiles of the Spokane River bottom, taken during Survey I at several locations between Coeur d'Alene and Post Falls, are shown in Figure 3. Longitudinal profiles of the bottom, along the approximate centerline of the river are shown in Figure 4. According to the USGS, the average elevation of the water surface of the Spokane River, on the day the profiles were made, was 2123.6 feet above mean sea level. Important features, which may have an impact upon water quality, include:

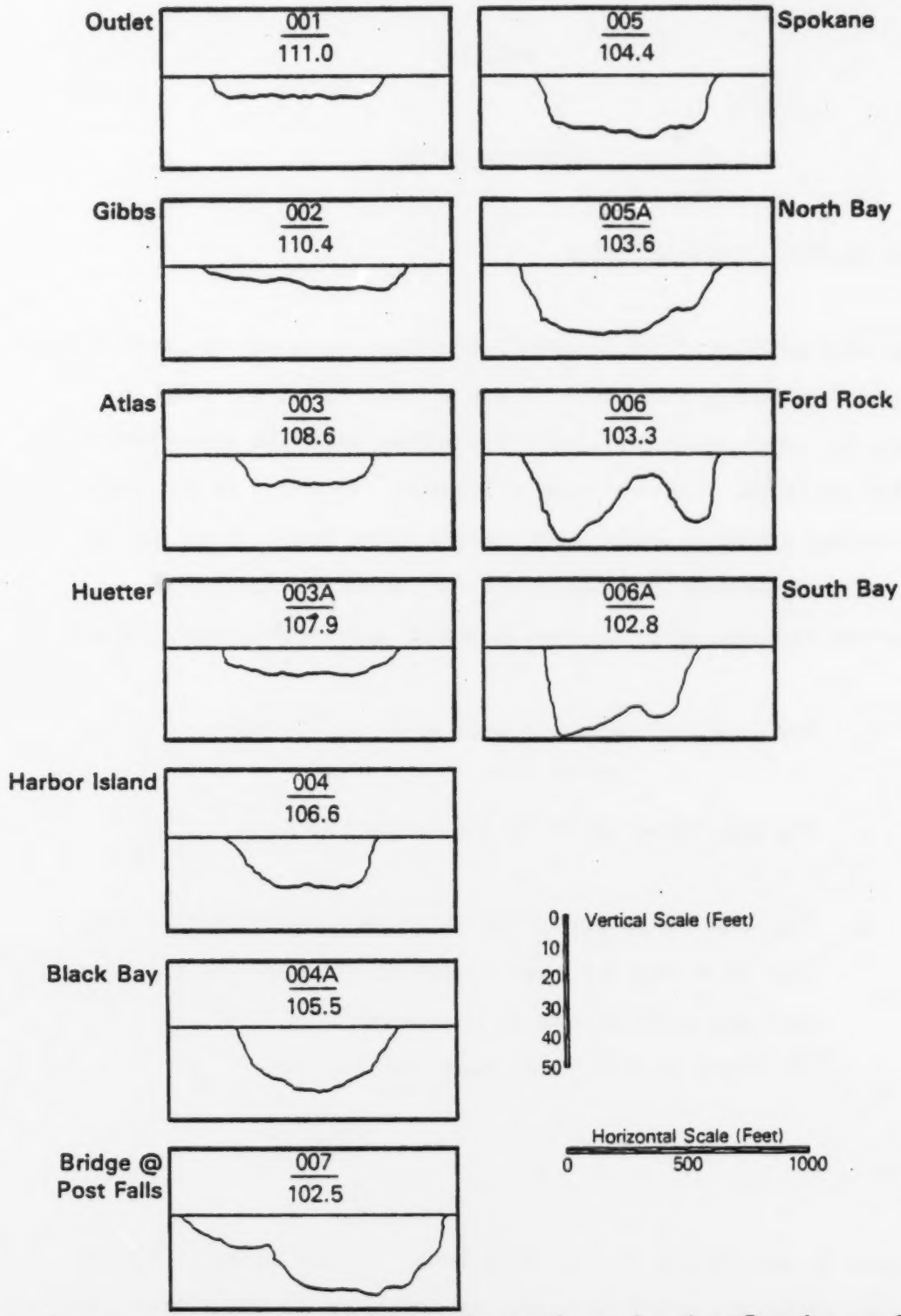
1. The broad sill between Green's Ferry and Ford Rock.

2. The deep "holes" on either side of Ford Rock.

3. The river bottom behind Post Falls Dam is approximately 2092 feet above mean sea level. Water is withdrawn from the river through a penstock with an inlet diameter of 11'3" and centerline at 2108.1 feet above mean sea level.

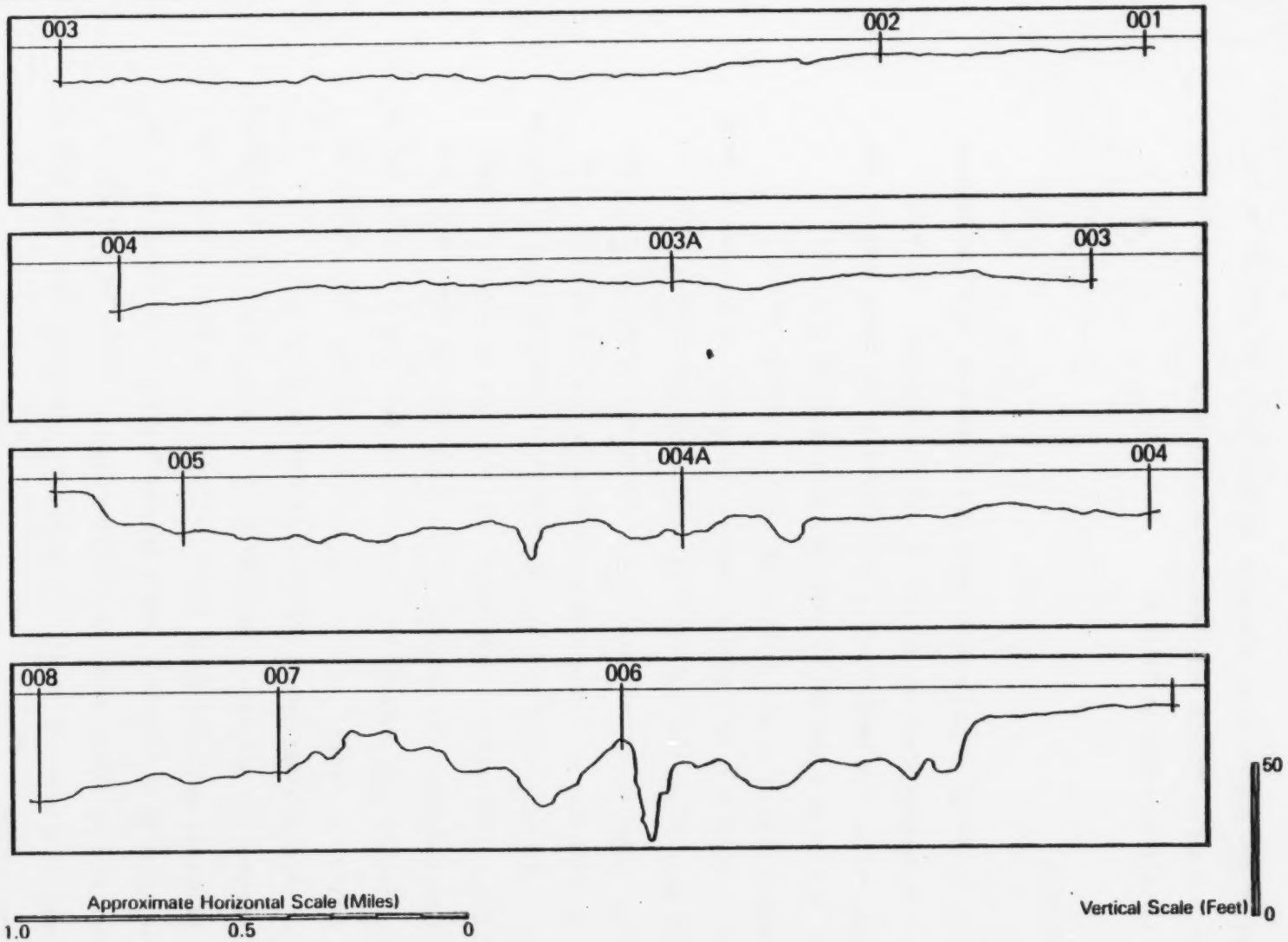
River Flow

We made no measurements of river flow during our four surveys. Instead we have relied upon the flow records maintained by the USGS. Provisional



River Cross-sections at Various Locations in the Spokane River between Coeur D'Alene and Post Falls (Pool Elevation = 2123.6 Feet above Mean Sea Level)

Figure 3



Longitudinal Profile along the Approximate Centerline of the Spokane River between Coeur D'Alene and Post Falls (Pool Elevation = 2123.6 Feet above Mean Sea Level)

Figure 4

values of the Spokane River discharge at Post Falls, diversions to the Rathdrum Prairie Project and elevation of Lake Coeur d'Alene during the four surveys are shown in Table 4.

Temperatures

Vertical profiles of temperature were made at several locations (Figure 2) in the Spokane River during each of the four surveys. Average, maximum and minimum temperatures, as measured during these surveys, are shown in Figures 5 through 8. Averages were computed as simple arithmetic average of all values measured at a station during a particular survey. This kind of average will result in a biased estimate of the mean if the vertical sampling interval is not uniform. The vertical sampling interval was not uniform during Surveys II, III, and IV. A comparison of simple averages and depth-weighted averages, at three locations where bias might be expected, showed a maximum difference of $0.2^{o}C$. Under these circumstances, we felt that the simple average would be adequate. The reported maxima and minima are the highest and lowest temperature, respectively, measured at each sample location during the particular survey. It should be kept in mind that these maxima and minima were obtained over a period of as much as three days. Furthermore, the accuracy with which we could locate a particular station was dependent upon wind speed and river current. In those parts of the river, such as at Ford Rock, where the depth changed rapidly we were not always able to obtain data from the same depths. There has been no attempt to account for these difficulties in computing either the mean or extreme values.

Table 4 Provisional values of daily discharge in the Spokane river, daily diversions to the Rathdrum Prairie Project and daily elevations of Lake Coeur d'Alene during EPA Region 10's Surveys I - IV.

Survey	Date	Daily Average Discharge of the Spokane River @ Post Falls (cfs)	Daily Average Diversion to the Rathdrum Prairie Project (cfs)	Daily Average Elevation of Lake Coeur d'Alene (ft above MSL)
	12/5/78	1530	0	2123.59
	12/6/78	1540	0	2123.52
	7/31/79	628	46	2127.90
	8/1/79	618	46	2127.88
	8/2/79	636	45	2127.87
	8/16/79	700	32	2127.78
	8/17/79	694	32	2127.80
	9/18/79	1350	0	2126.59
	9/19/79	1350	0	2126.55
	9/20/79	1350	0	2126.53

Figure 5. Average, maximum and minimum water temperatures in the Spokane River during Survey I (December 5-6, 1978).

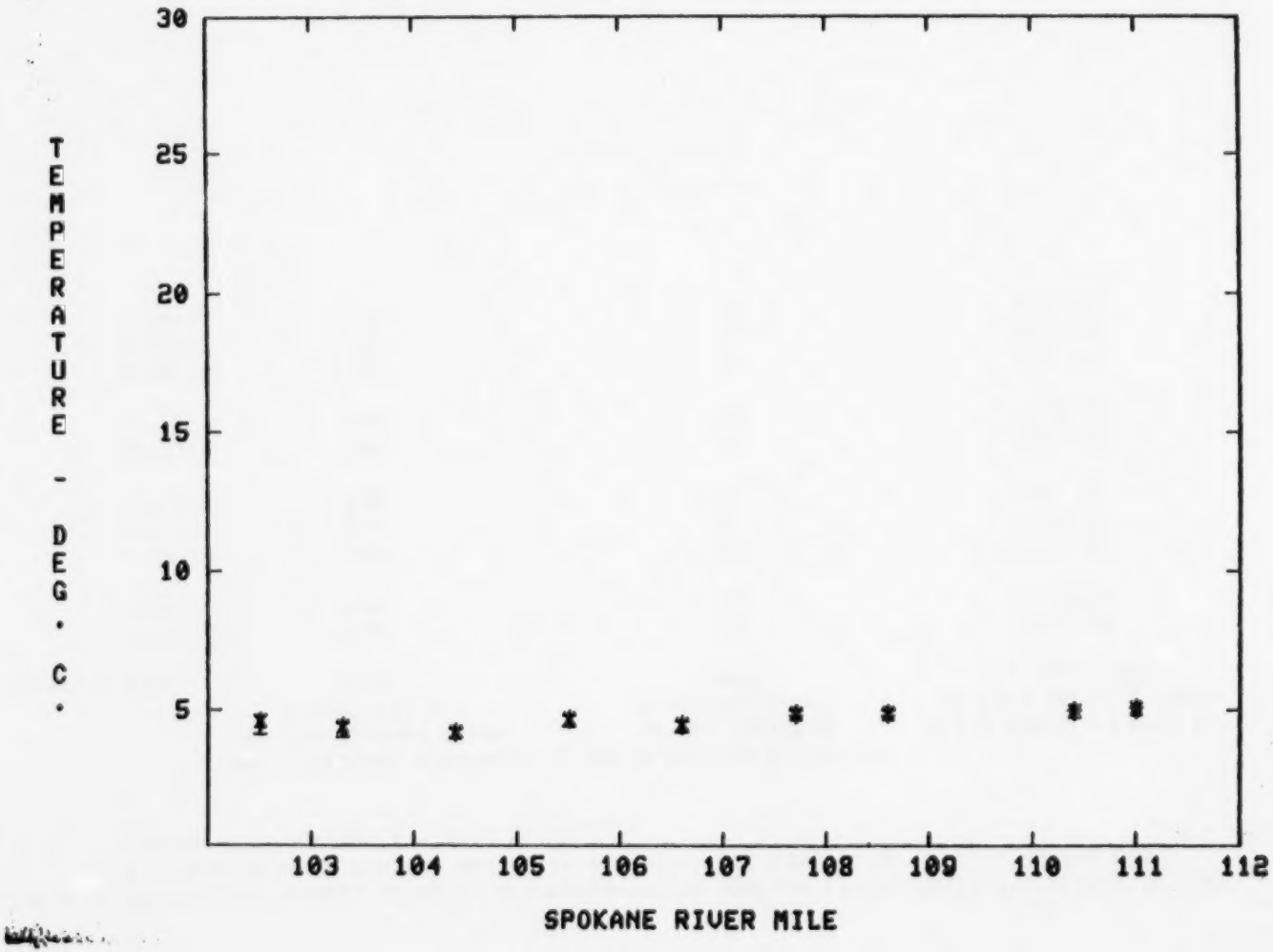


Figure 6. Average, maximum and minimum water temperatures in the Spokane River during Survey II (July 31 - August 2, 1979).

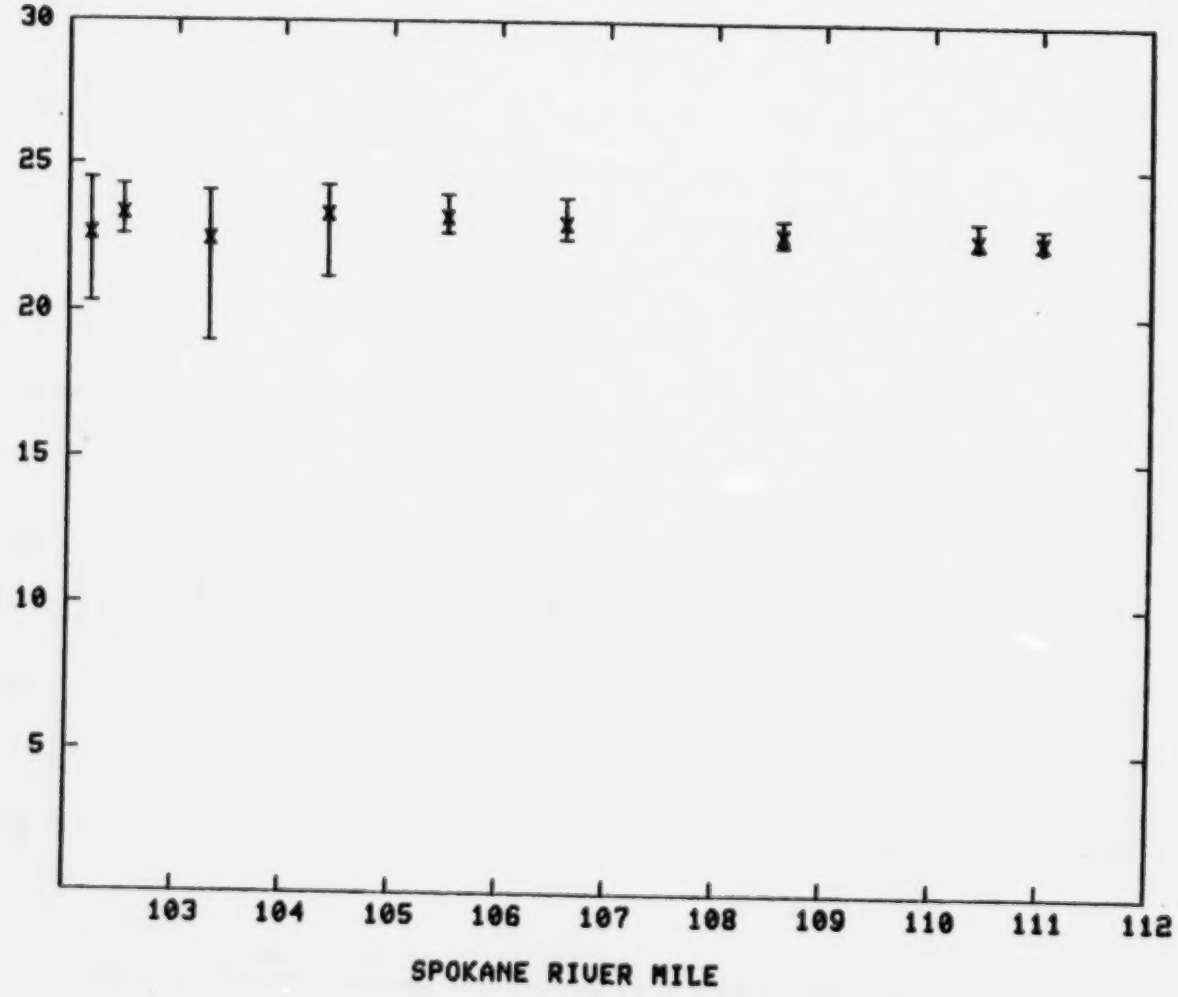


Figure 7. Average, maximum and minimum water temperatures in the Spokane River during Survey III (August 16-17, 1979).

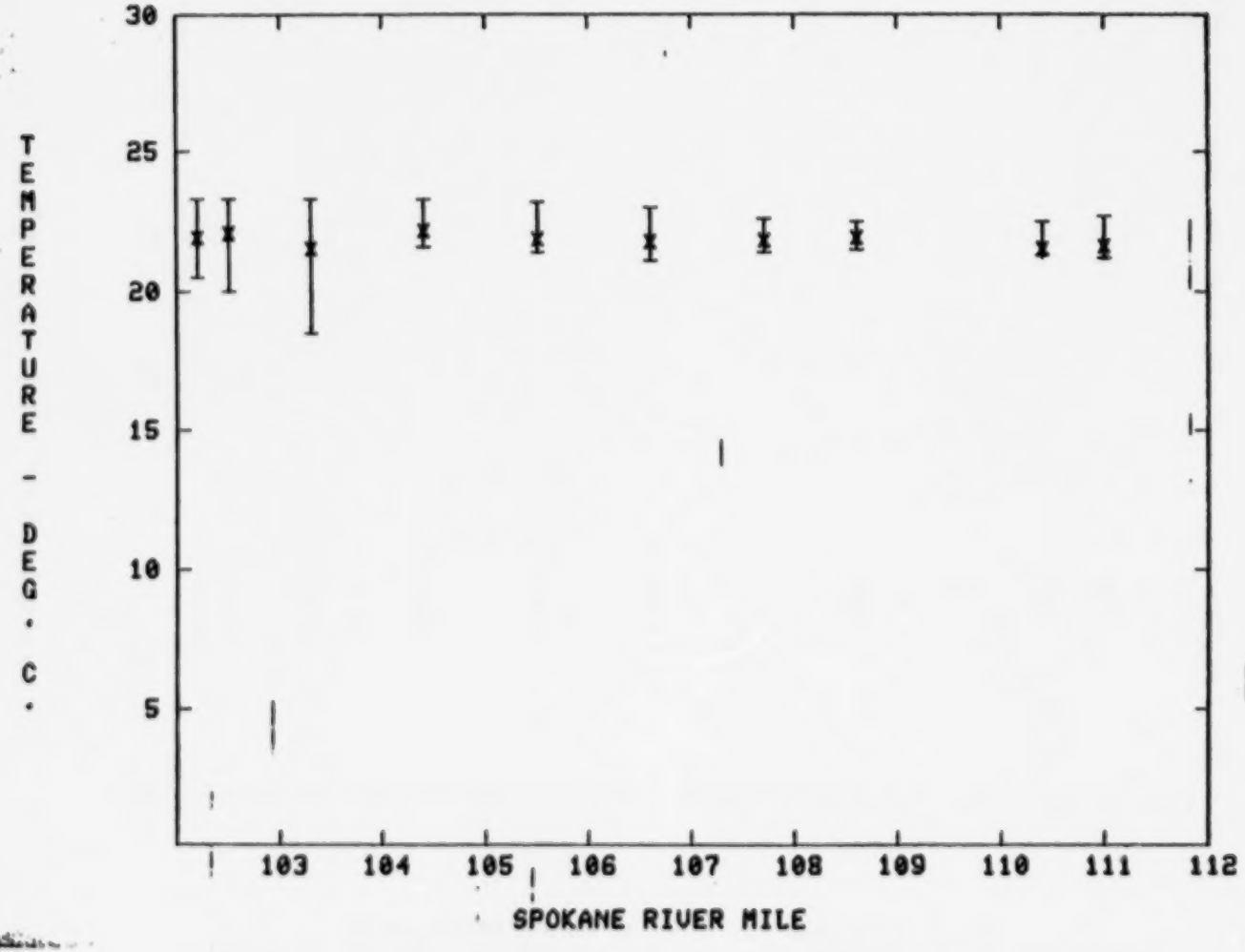
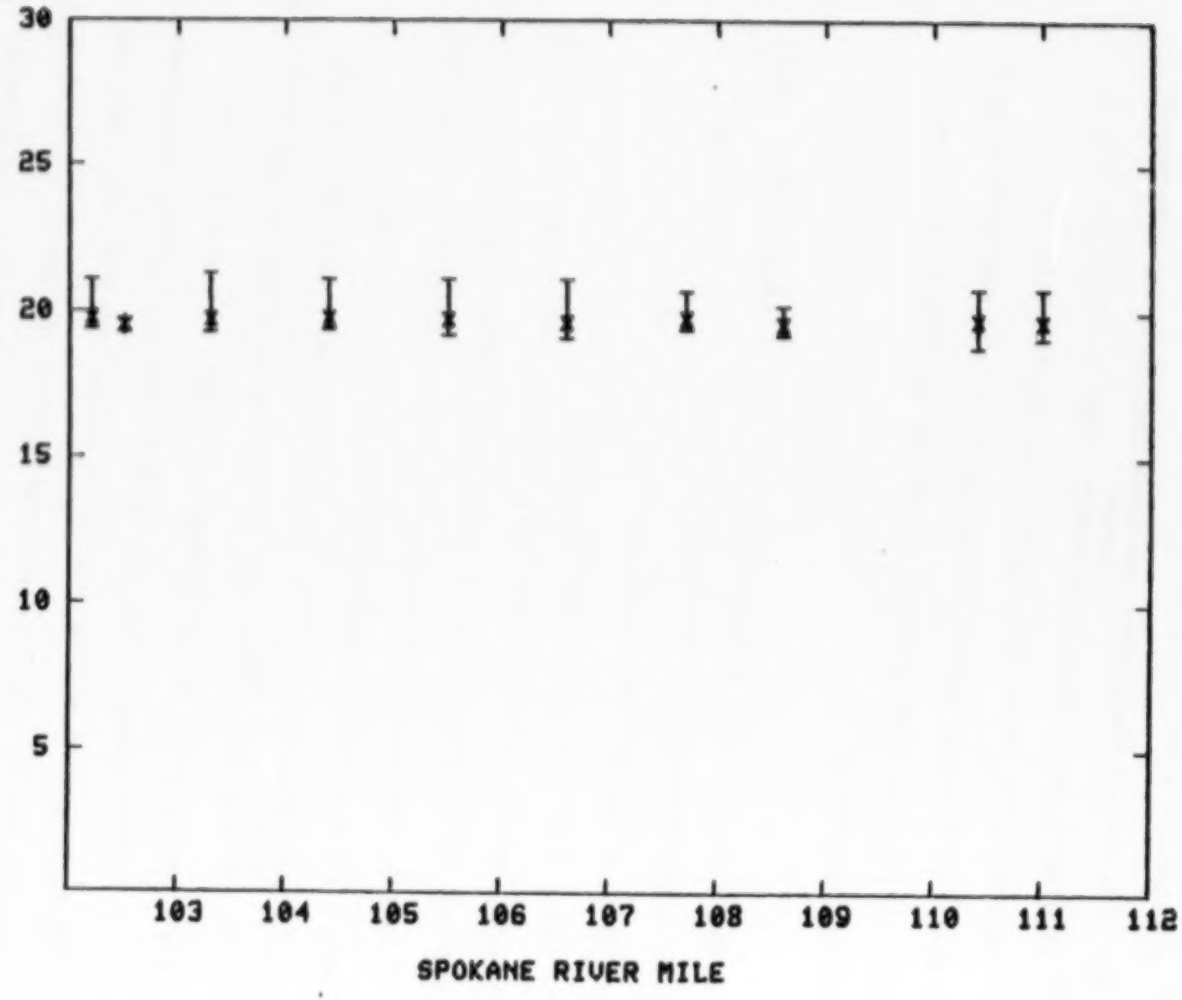


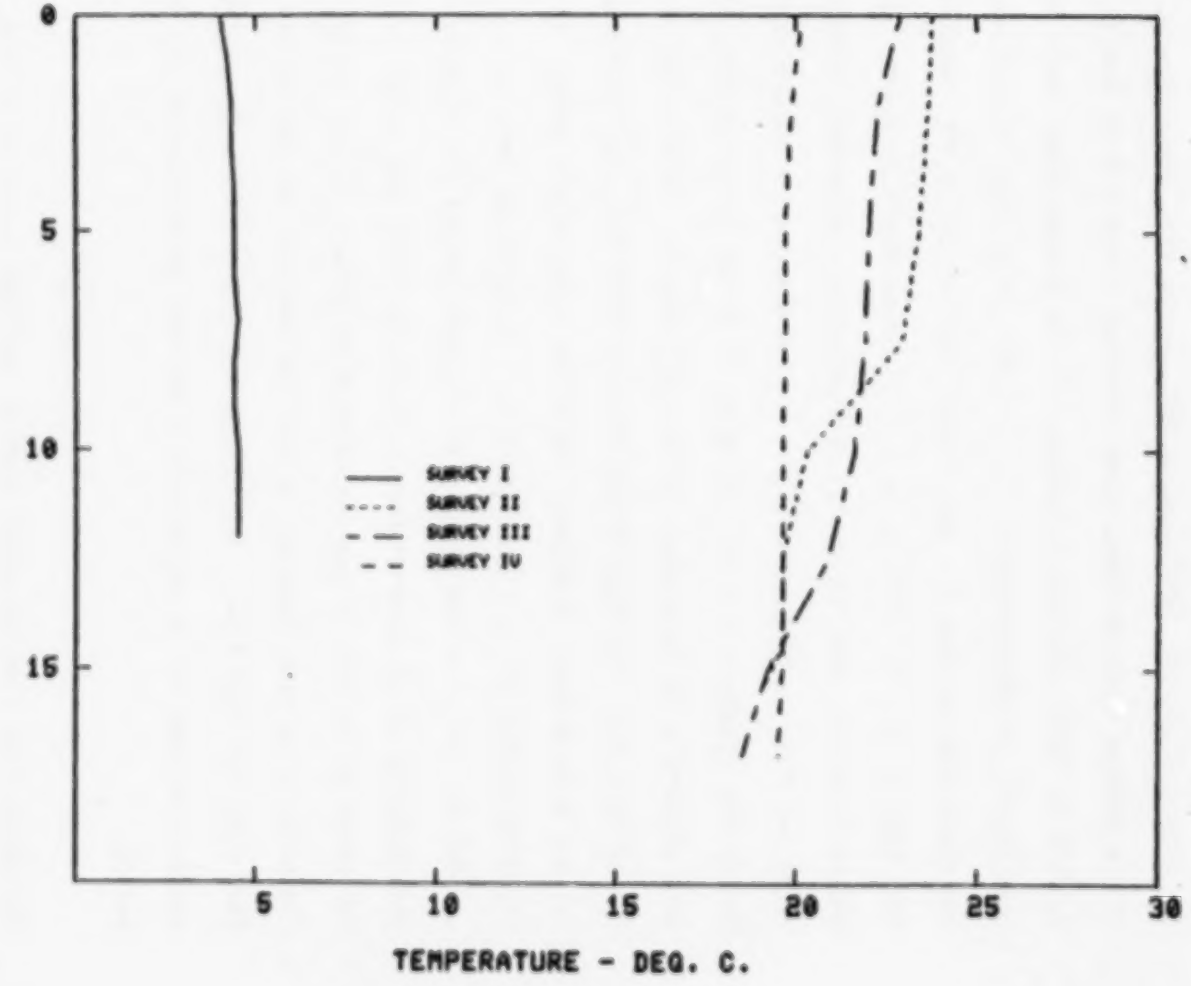
Figure 8. Average, maximum and minimum water temperatures in the Spokane River during Survey IV (September 18-20, 1979)



During Survey I (December 5-6, 1978), the average water temperature varied from 4.0°C to 5.1°C. The highest average temperature of 5.1°C was measured near the outlet of Lake Coeur d'Alene (River Mile 110.0). The average temperature decreased downstream to a minimum of 4.2°C at Green's Ferry (River Mile ~~103.1~~ 104.4), then increased slightly to 4.6°C at Post Falls (River Mile 102.5). The maximum vertical variations (difference between maximum and minimum temperature at each sample station) in temperature at any of the sampling locations was 0.9°C at Post Falls.

During Surveys II (July 31-August 2, 1979) and III (August 16-17, 1979) water temperatures varied from 18.5°C to 24.5°C. The longitudinal variation of average temperature was less than 0.8°C during both surveys. There was a substantial vertical variation in temperature, however, particularly at those locations such as Ford Rock (R.M. 103.5) and Post Falls Dam (R.M. 102.2) where water depths equalled or exceeded 10 meters. During Surveys II and III vertical variations at Ford Rock were 5.1°C and 5.0°C, respectively, and at Post Falls Dam were 4.2°C and 3.8°C, respectively. At the shallower, upstream stations (R.M. ~~110.0~~ 111.0 to R.M. ~~106.4~~ 105.5) the vertical variation was between 0.7°C and 1.8°C during Survey II and between 1.0°C and 1.9°C during Survey III. Surface temperatures, during both surveys increased downstream. The difference in vertical variation between the shallower, upstream stations and the deeper, downstream stations was due to the colder water found at depths of 10 meters and below. At Ford Rock, for example, the temperature at 10 meters and below was between 19.0°C and 20.7°C

Figure 9. Average vertical temperature profile at Ford Rock (Spokane River Mile 103.3) Surveys I, II, III and IV.



during Survey II (Figure 9). Water temperatures (USGS provisional data) in the Spokane River below Post Falls (Spokane River Mile 100.7) on June 25, 1979 and July 23, 1979, were 18.0°C. and 24.0°C., respectively. If one assumes that the temperature increased linearly from June 25, 1979 to July 23, 1979, then the temperature in the Spokane River would have been 19.0°C. on approximately July 1, 1979. Given these assumptions, one could then estimate the approximate "age" of the 19.0°C. water at Ford Rock on July 31, 1979, to be a little more than four weeks. By the middle of August, when Survey III was conducted, the warmer, surface water had mixed to 10 meters raising the temperature to between 21.3° and 22.0°C. Temperatures at, and below, 15 meters during Survey III were comparable to those measured during Survey II. At the time of Survey III, then, the "age" of the water at Ford Rock, for depths equal to, and greater than, 15 meters, was on the order of six weeks. This characterization of the thermal structure at Ford Rock does not take into account the effect of the drop in air temperature and the substantial precipitation which occurred August 14 and 15, 1980; the effect is reflected by the drop in average temperature between Surveys II and III. The point to be made, however, is that the depth of the thermocline at Ford Rock increased from Survey II and III, and that water below the thermocline remained at essentially a constant temperature during this period.

Increased river flow and cooler weather resulted in nearly uniform, but lower average temperature in Survey IV (September 18-20, 1979), compared to Surveys II and III. Vertical variations in temperature were equal to,

or less than, 2.0°C at all sample locations. Minimum water temperatures at the bottom were similar at all sample stations, regardless of depth.

Dissolved Oxygen

Average, maximum and minimum dissolved concentration and saturation levels measured during the four surveys are shown in Figures 10 through 13 and 14 through 17. Figures 18 and 19 show vertical profiles of concentration and saturation, respectively, at Ford Rock.

Dissolved oxygen concentrations and saturation levels were nearly uniform, both longitudinally and vertically, during Survey I (December 5-6, 1978). Concentrations ranged from 9.8 mg/l to 10.7 mg/l and saturation levels from 80.8% to 89.6%.

The response of dissolved oxygen to elevated water temperatures and reduced stream flow was reflected in the observations of Surveys II (July 31-August 2, 1979) and III (August 16-17, 1979). During Survey II, dissolved oxygen saturation levels generally exceeded saturation at the surface of the water, but were always less than saturation at the bottom. At the shallower stations (R.M. 111.0 to 105.5) the saturation levels at the bottom were equal to, or greater than, 84.8%. However, at the deeper, downstream stations, saturation levels as low as 33.0% were measured.

Despite the fact that water temperatures had dropped, the dissolved oxygen conditions were worse during Survey III (August 16-17, 1979) than during Survey II. Surface values of dissolved oxygen at the two upstream stations (R.M. 111.0 and 110.4) were above saturation levels. Stations downstream from there had levels ranging from 86.8% to 95.6%. Saturation levels at the bottom were less than 85.6% at all stations, with minimum levels of 2.3% to 10.6% found at the bottom for the three downstream stations (R.M. 103.3, 102.5 and 102.2).

The overall reduction in dissolved oxygen during Surveys II and III are related to the summer low-flow conditions of long residence time and high water temperature. The particularly severe problems at the deep, downstream stations are a result of topographical influences (Figure 4) acting in concert with the development of thermal stratification. The water at depth in these places is prevented from mixing with the main river by the density gradient which suppresses vertical movement, and by the bottom topography or turbine invert depth which suppresses downstream movement. As a result, the water in these places has little opportunity reaeration and substantial opportunity for deoxygenation. Minimum concentrations at Ford Rock and Post Falls were 2.9 mg/l and 2.8 mg/l, respectively, during Survey II, and 0.5 mg/l and 0.9 mg/l, respectively, during Survey III.

By the time of Survey IV (September 18-20, 1979), with river flows rising and water temperature dropping, dissolved oxygen conditions improved substantially. Saturation levels varied between 86.0% and 100.7%, while concentrations varied from 7.5 mg/l to 8.7 mg/l.

Figure 10. Average, maximum and minimum dissolved oxygen concentrations in the Spokane River during Survey I (December 5-6, 1978).

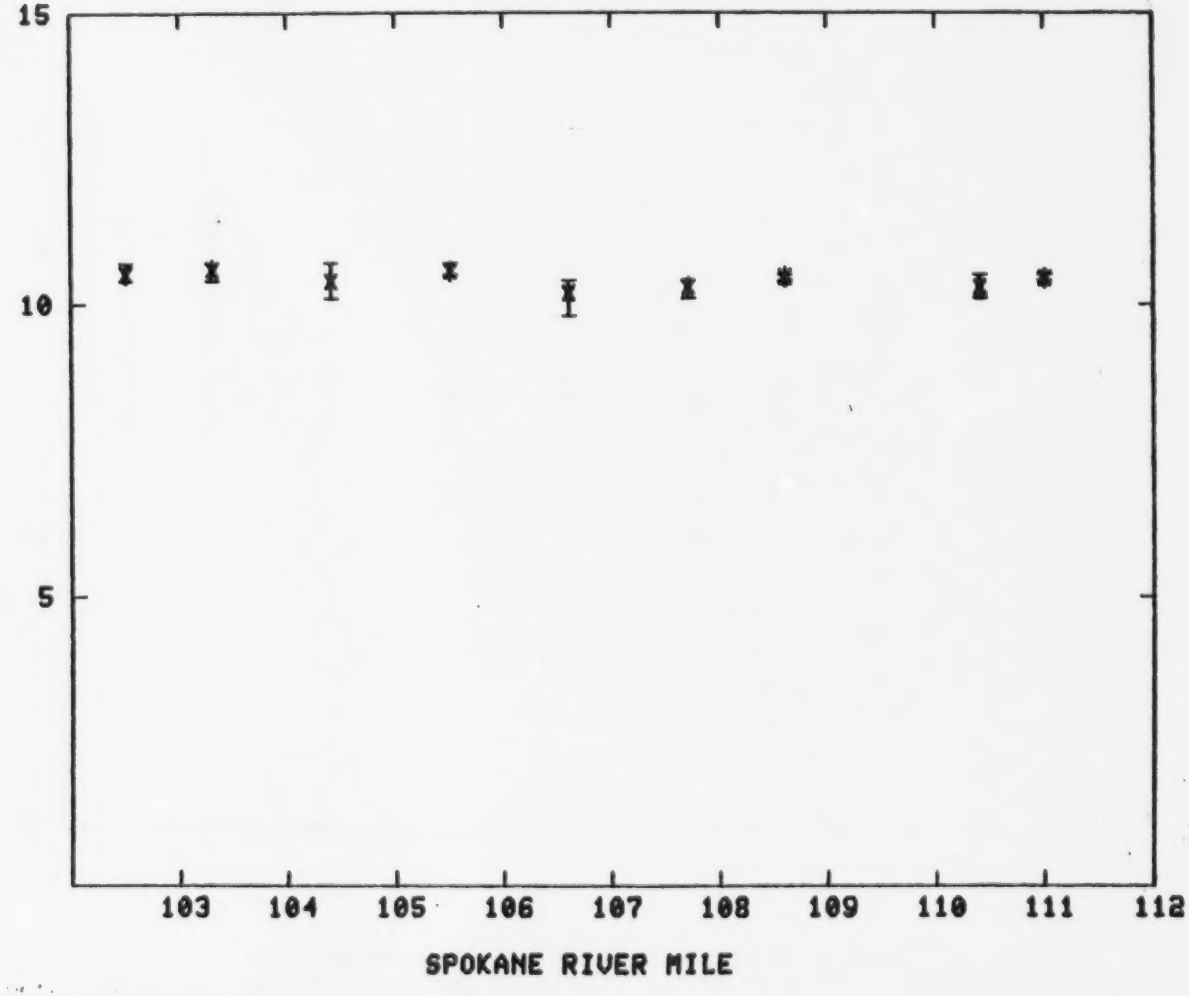


Figure 11. Average, maximum and minimum dissolved oxygen concentrations in the Spokane River during Survey II (July 31-August 2, 1979)

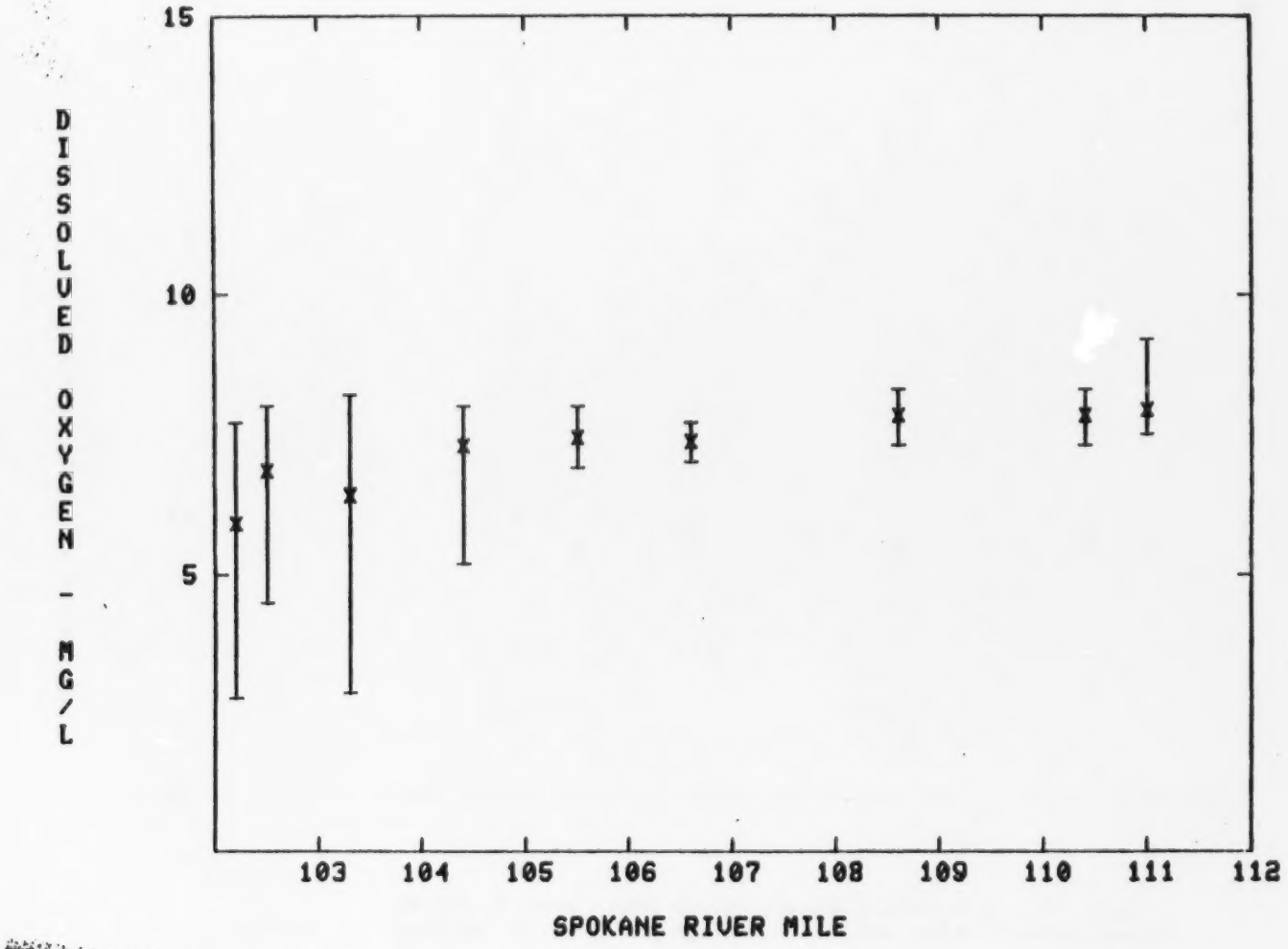


Figure 12. Average, maximum and minimum dissolved oxygen concentrations in the Spokane River during Survey III (August 16-17, 1979).

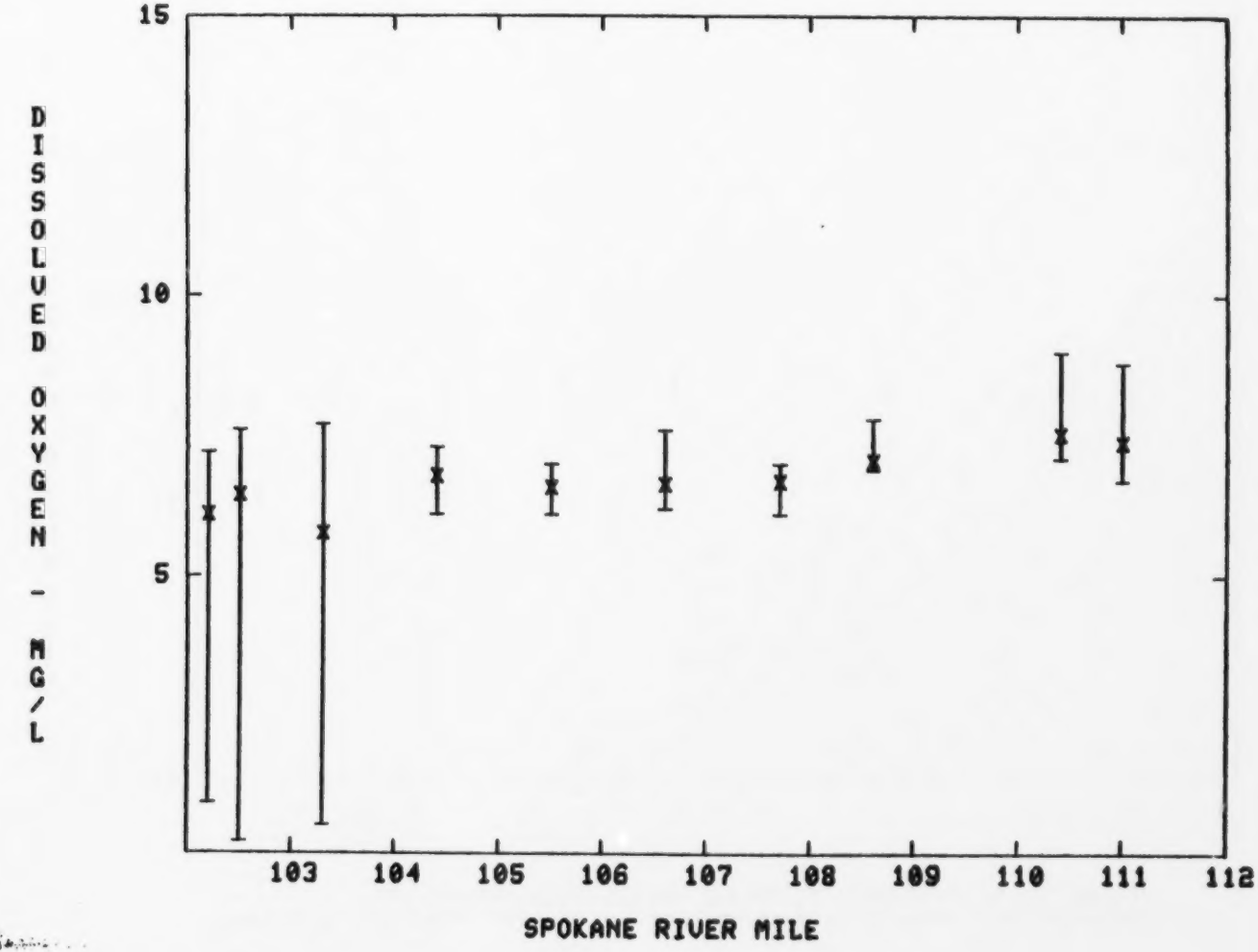


Figure 13. Average, maximum and minimum dissolved oxygen concentrations in the Spokane River during Survey IV (September 18-20, 1979).

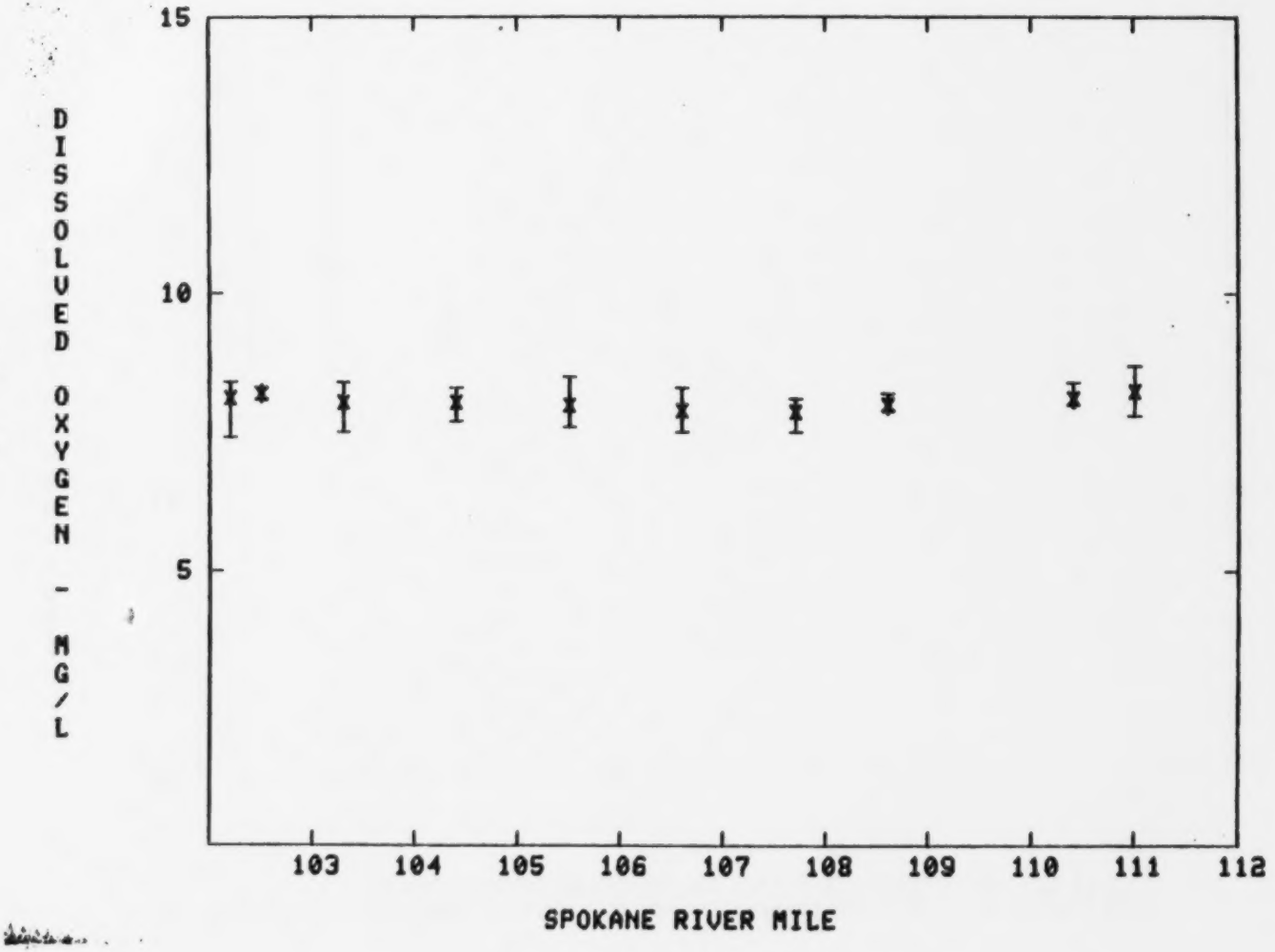


Figure 14. Average, maximum and minimum dissolved oxygen saturation levels in the Spokane River during Survey I (December 5-6, 1978).

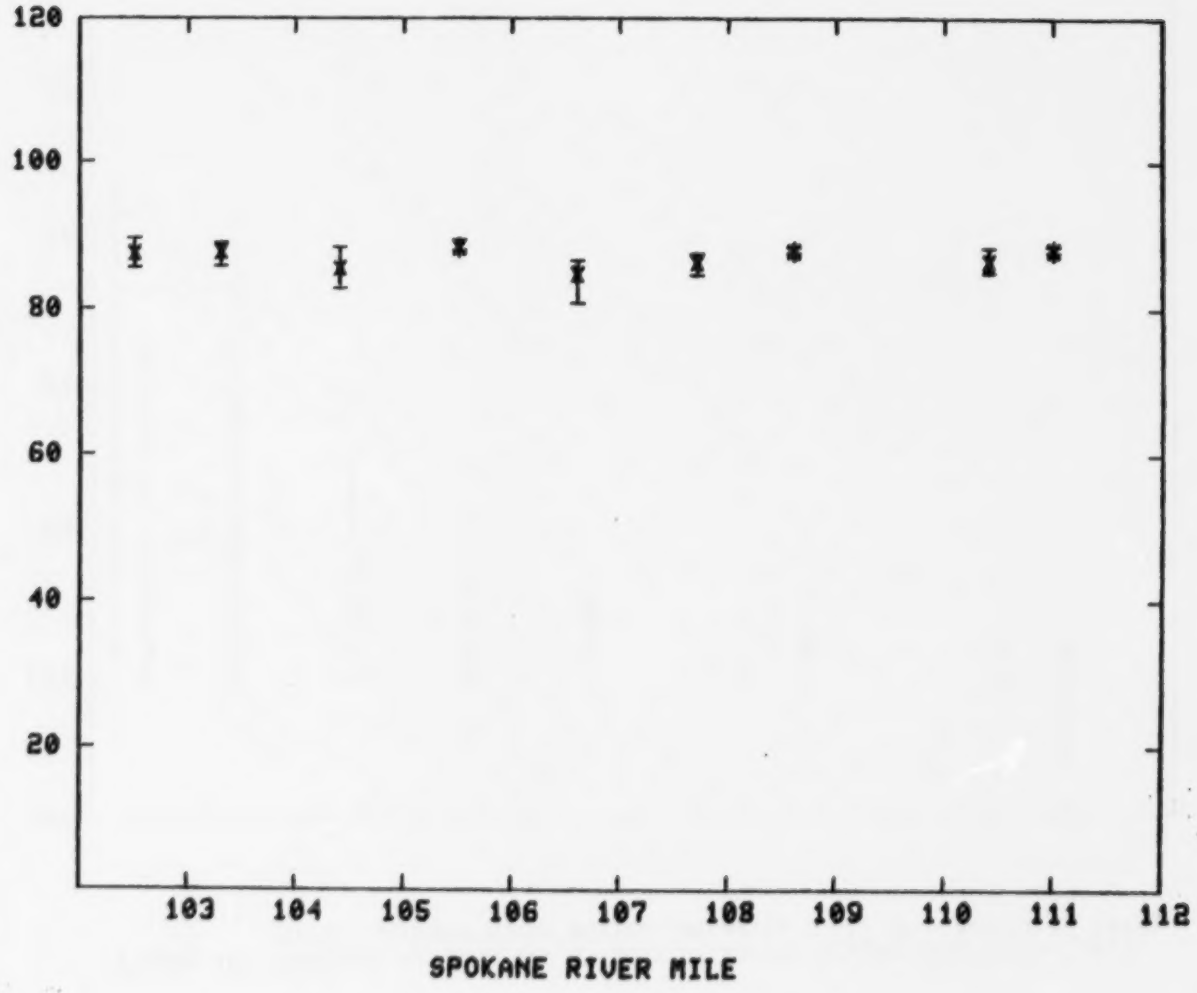


Figure 15. Average, maximum and minimum dissolved oxygen saturation levels in the Spokane River during Survey II (July 31 - August 2, 1979).

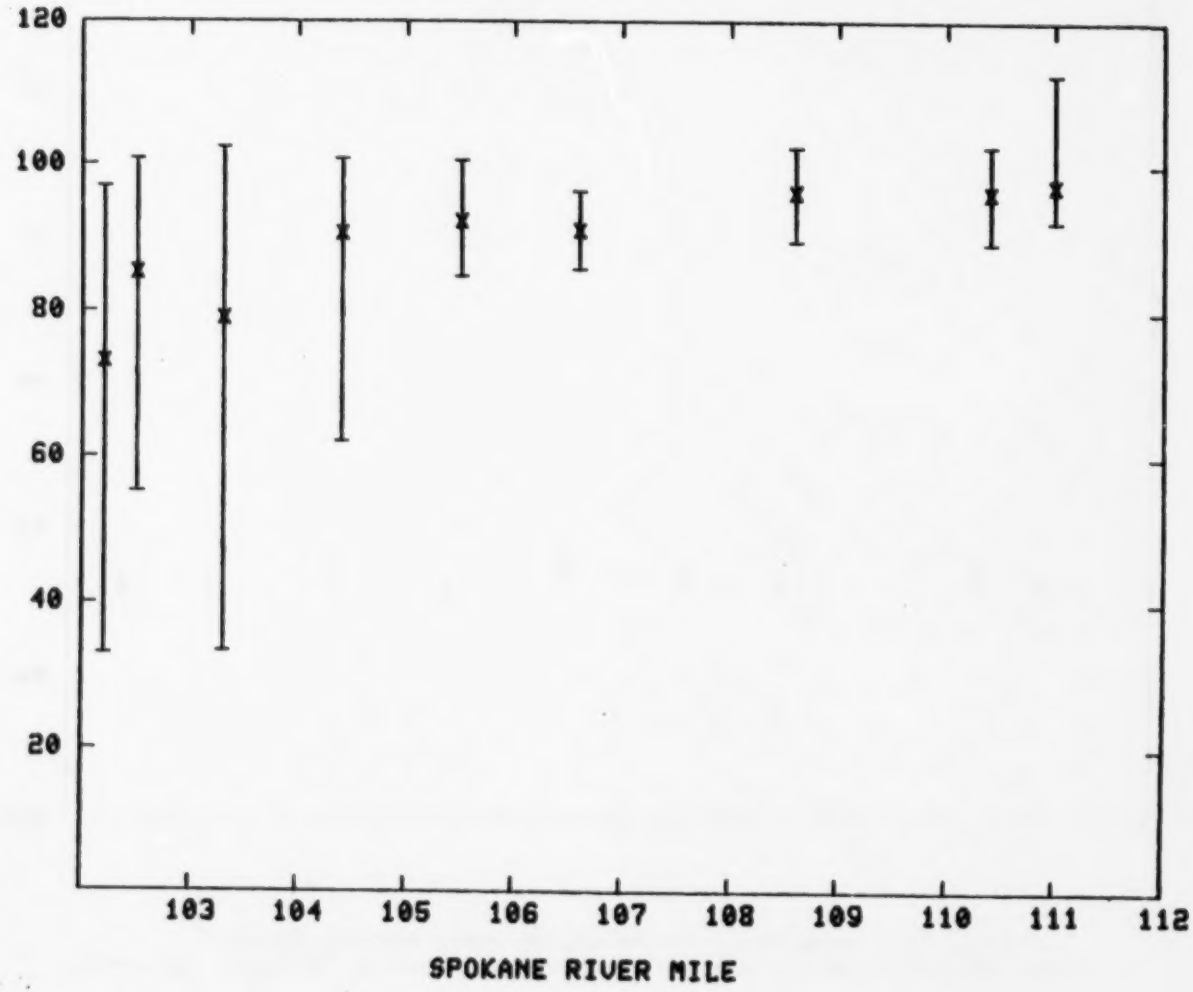


Figure 16. Average, maximum and minimum dissolved oxygen saturation levels in the Spokane River during Survey III (August 16-17, 1979).

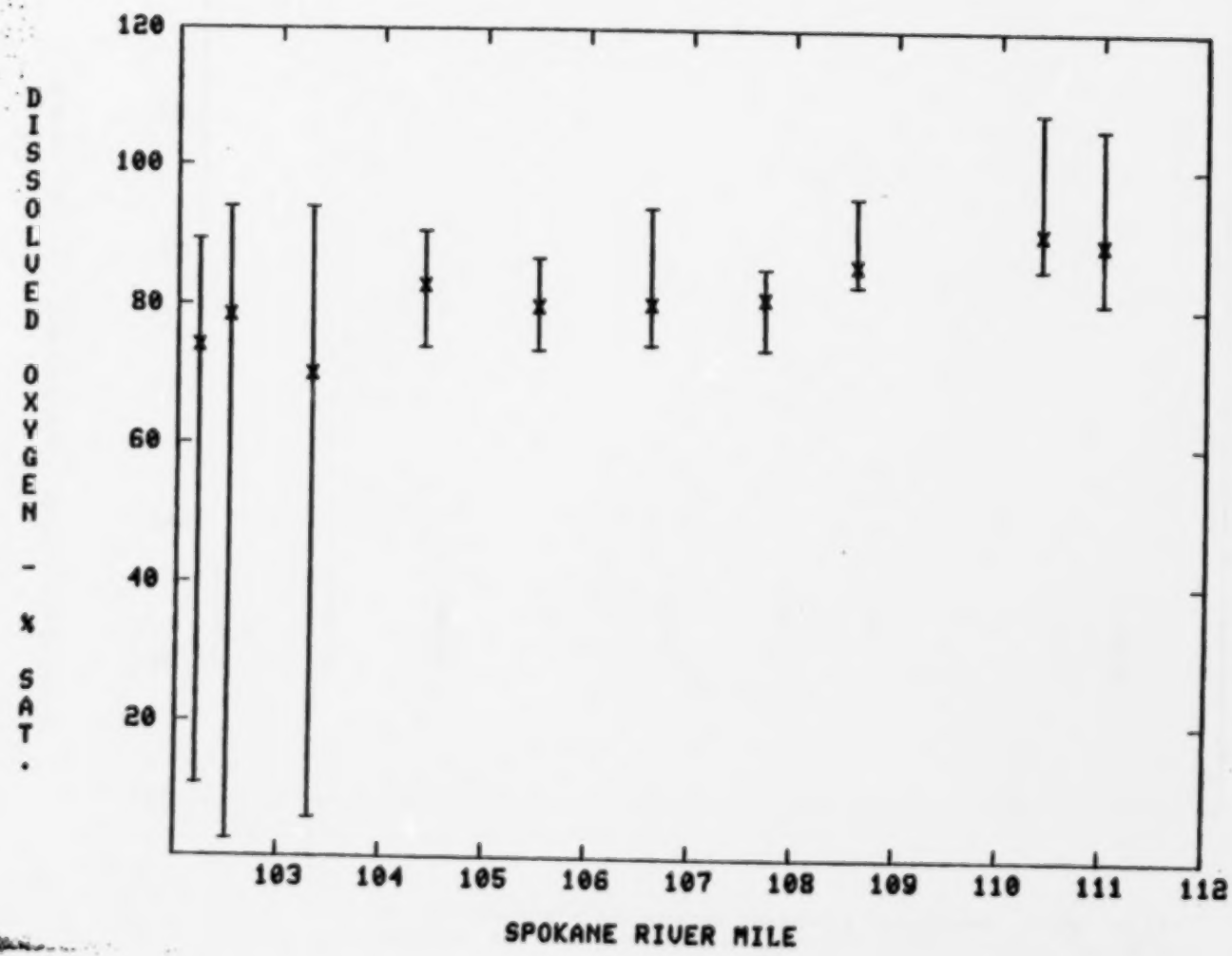


Figure 17. Average, maximum and minimum dissolved oxygen saturation levels in the Spokane River during Survey IV (September 18-20, 1979).

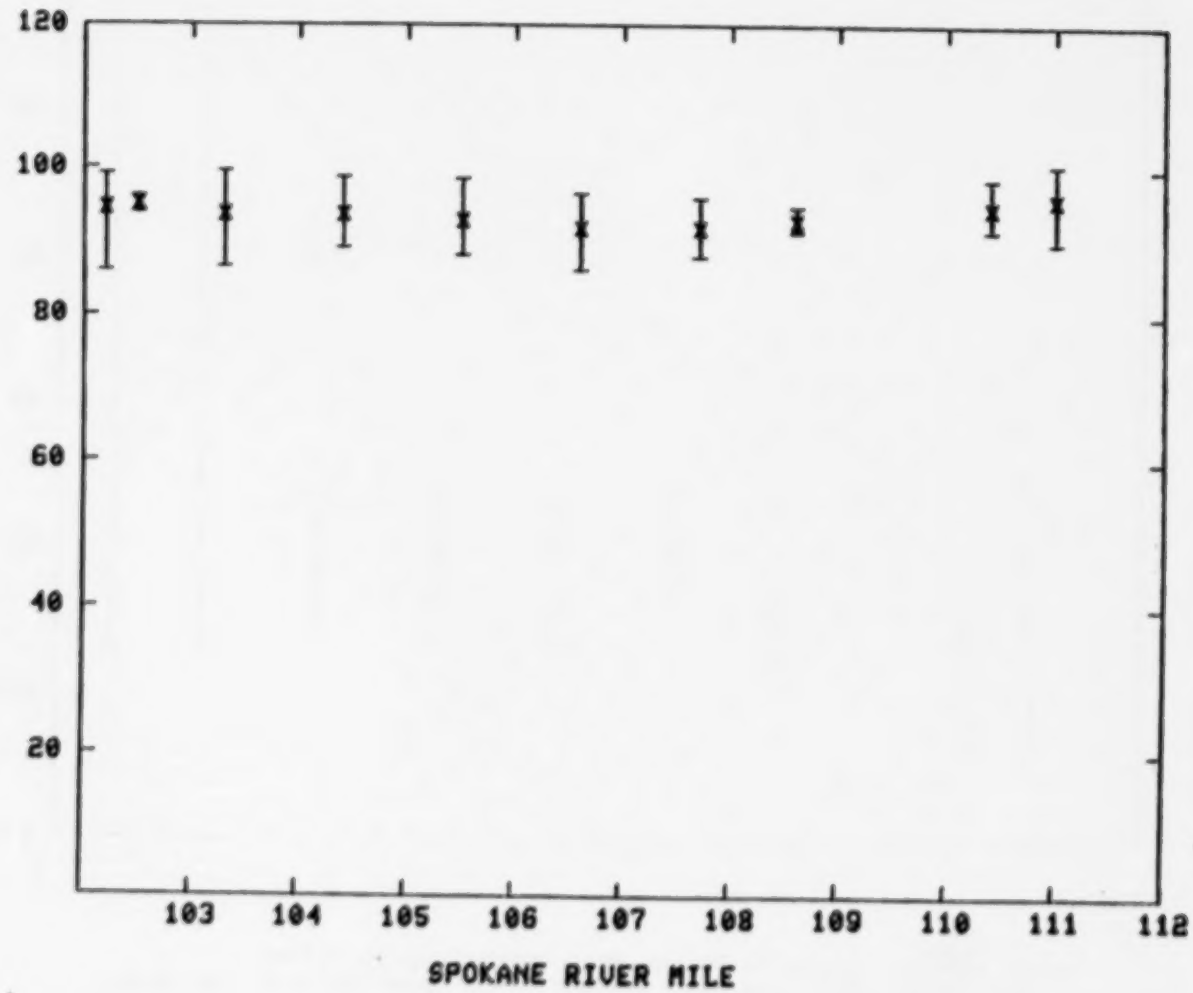


Figure 18. Average vertical dissolved oxygen concentration profile at Ford Rock (Spokane River Mile 103.3) during Surveys I, II, III, and IV.

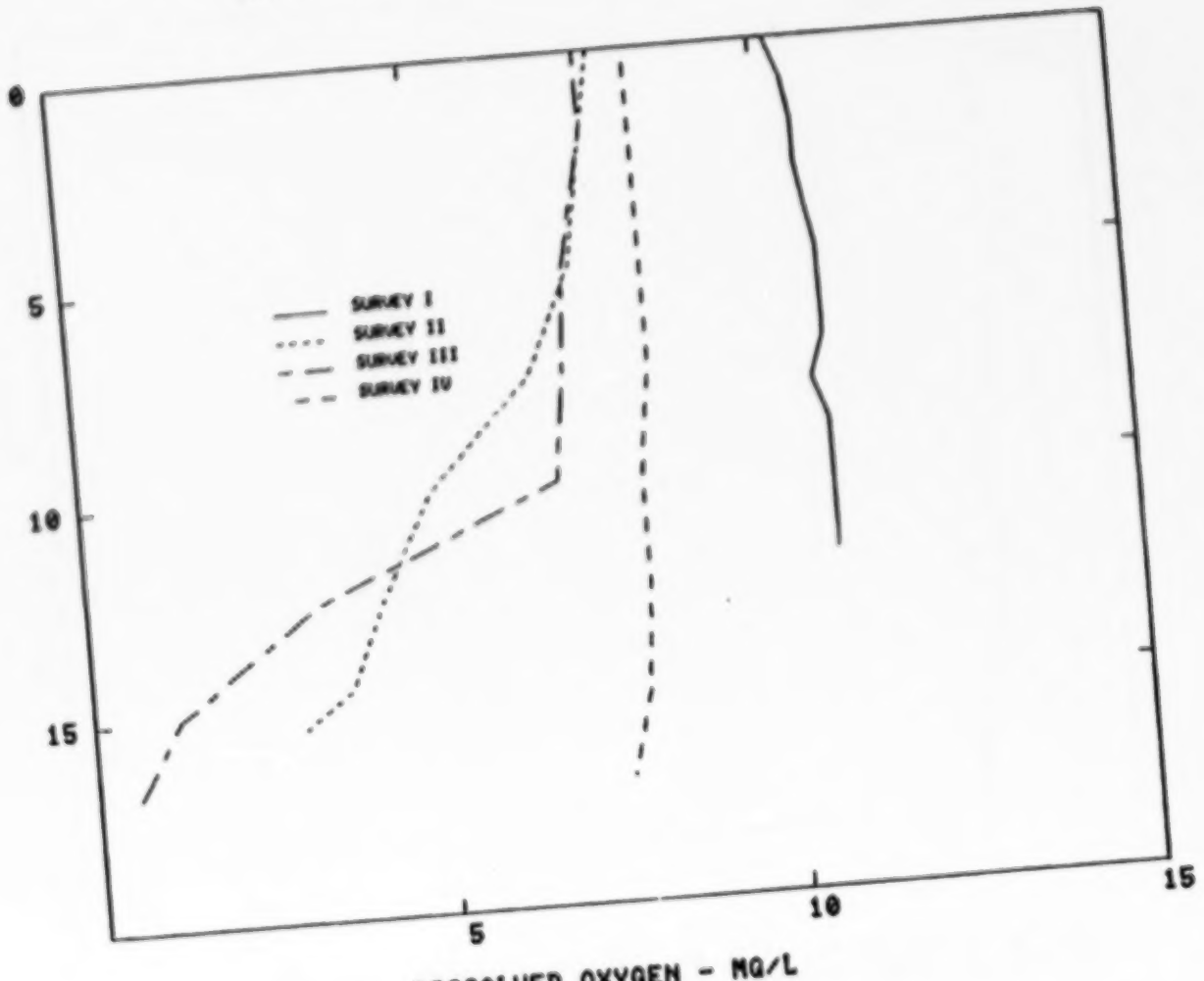
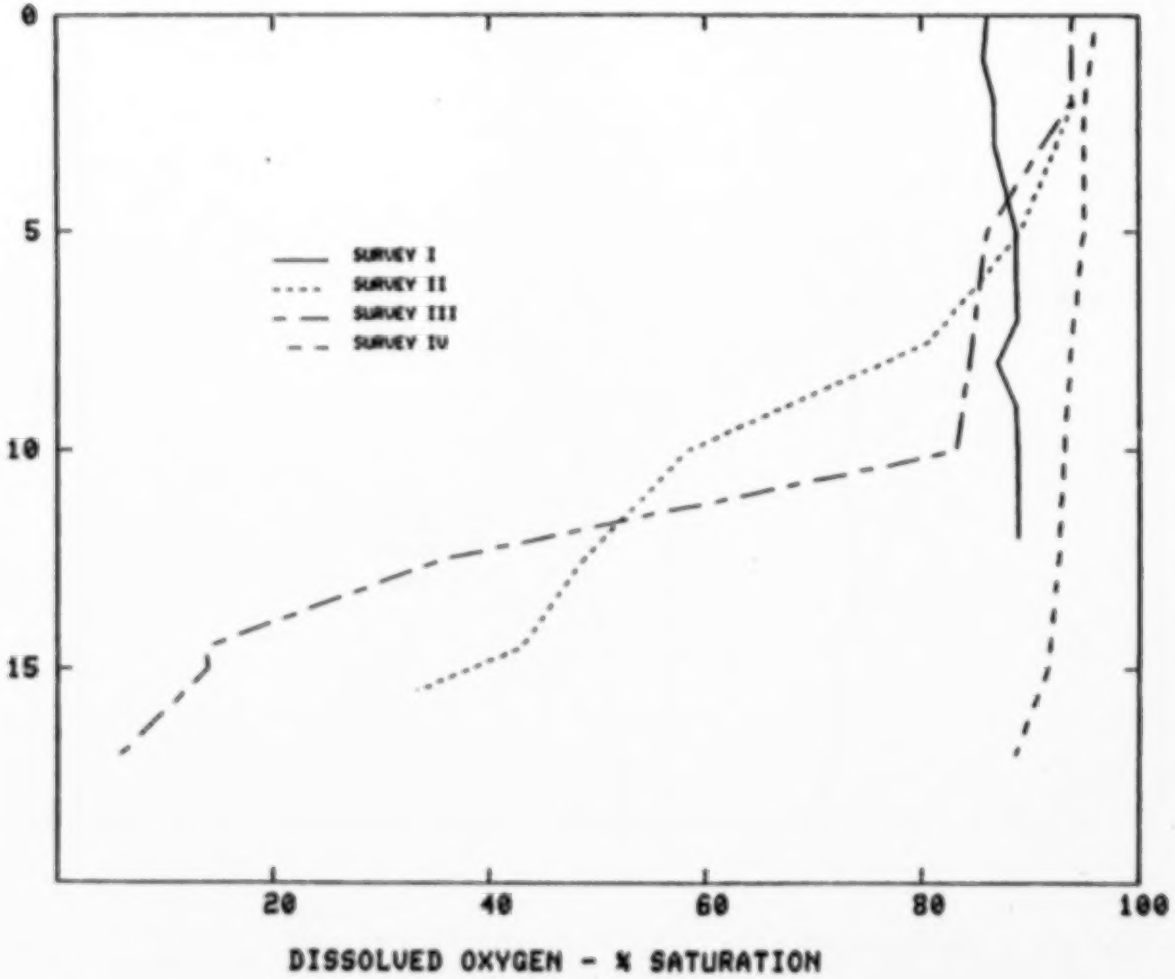


Figure 19. Average vertical dissolved oxygen saturation level profile at Ford Rock (Spokane River Mile 103.3) during Surveys I, II, III, IV.



Conductivity and pH

Conductivity and pH were measured during Surveys II, III, and IV, only. Conductivity showed little variation during the period from July 31, 1979, to September 20, 1979. Maximum conductivity was 70 umho/cm and minimum conductivity was 50 umho/cm.

pH levels varied from a low of 6.3, in the deep water at Ford Rock, to a high of 7.6 in the surface water near the outlet of Lake Coeur d'Alene. In general, the high pH levels corresponded to high dissolved oxygen, and low pH to low dissolved oxygen.

Nutrients

Concentration of the various forms of nitrogen and phosphorus were measured during Surveys II (July 31, 1979) and IV (September 18-20, 1979). Inorganic nitrogen levels (NH_3-N and NO_2+NO_3-N) were less than 0.03 mg/l during both surveys. During Survey II 70% of the samples had concentrations of NO_2+NO_3-N less than the detection limit of 0.01 mg/l. 48% of the samples were below the detection limit for NO_2+NO_3-N during Survey IV.

Dissolved orthophosphate was equal to, or less than, 0.02 mg/l at all sample stations during Surveys II and IV. During both surveys, however, the sampling stations upstream from the Coeur d'Alene sewage treatment plant had concentrations which were less than the level of detection,

0.01 mg/l, while at the station just downstream from the plant we found concentrations of 0.02 mg/l in all samples collected.

Total phosphorus (Figures 19 and 20) and, to a lesser degree, total nitrogen (Figures 21 and 22) were influenced by the discharge from the City of Coeur d'Alene's treatment plant. In Survey II, average total phosphorus in the Spokane River increased from 0.024 mg/l to 0.038 mg/l at stations upstream and downstream, respectively, from the treatment plant. The corresponding increase during Survey IV was from 0.011 mg/l to 0.056 mg/l.

For total nitrogen the increase was from 0.33 mg/l to 0.38 mg/l during Survey II and from 0.16 mg/l to 0.36 mg/l during Survey IV.

Total Organic Carbon

The results of in-stream measurements of total organic carbon are shown in Figures 23 and 24 for Surveys II (July 31-August 2, 1979) and IV (September 18-20, 1979). Values ranged from 1 mg/l to 8 mg/l, with the highest values occurring at the Harbor Island sampling station (R.M. 106.5). During Survey IV, total organic carbon concentrations were very nearly uniform from the outlet of Lake Coeur d'Alene to Post Falls Dam, varying from 1 mg/l to 2 mg/l.

Figure 20. Average, maximum and minimum total phosphorus concentrations in the Spokane River during Survey II (July 31 - August 2, 1979).

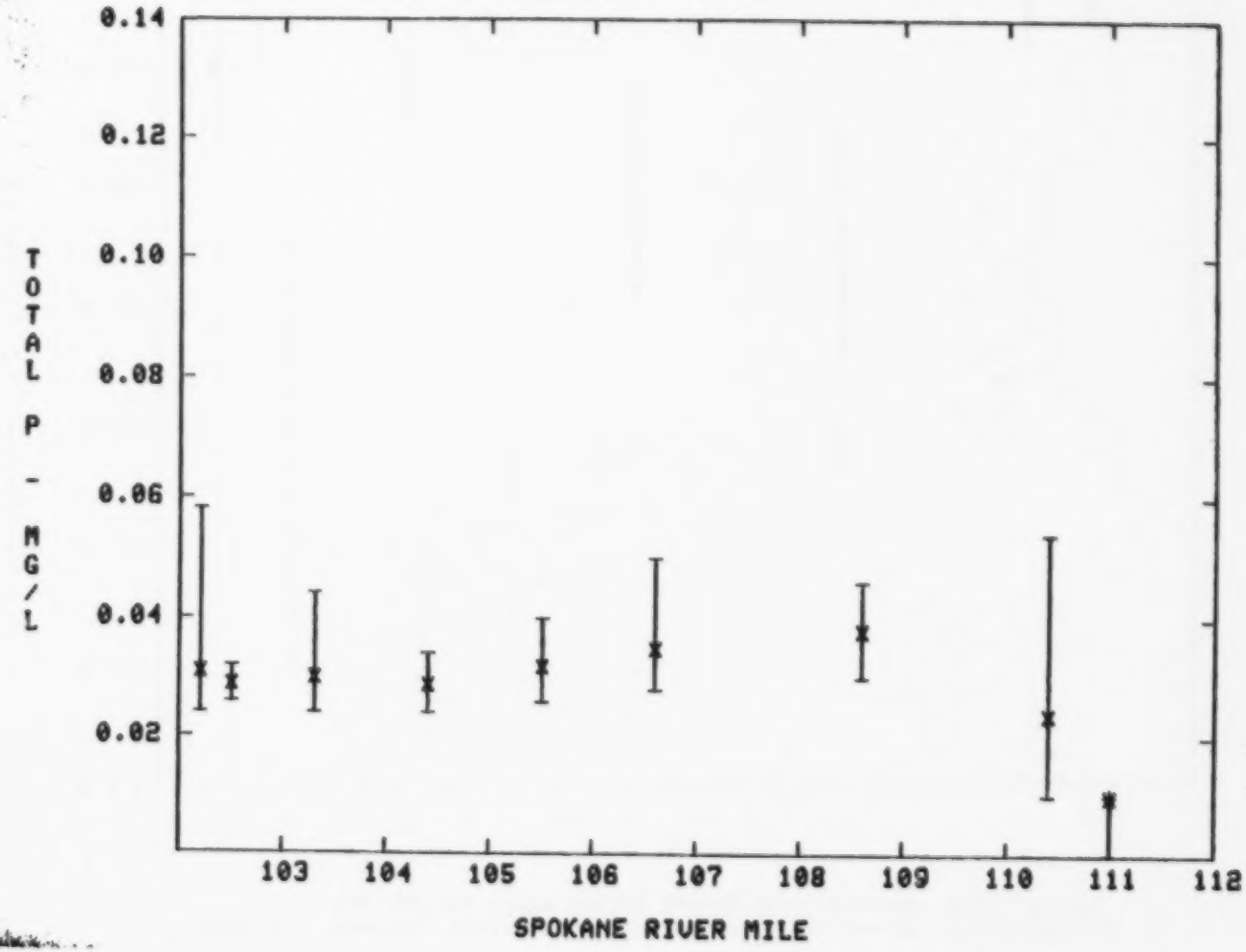


Figure 21. Average, maximum and minimum total phosphorus concentrations in the Spokane River during Survey IV (September 18-20, 1979).

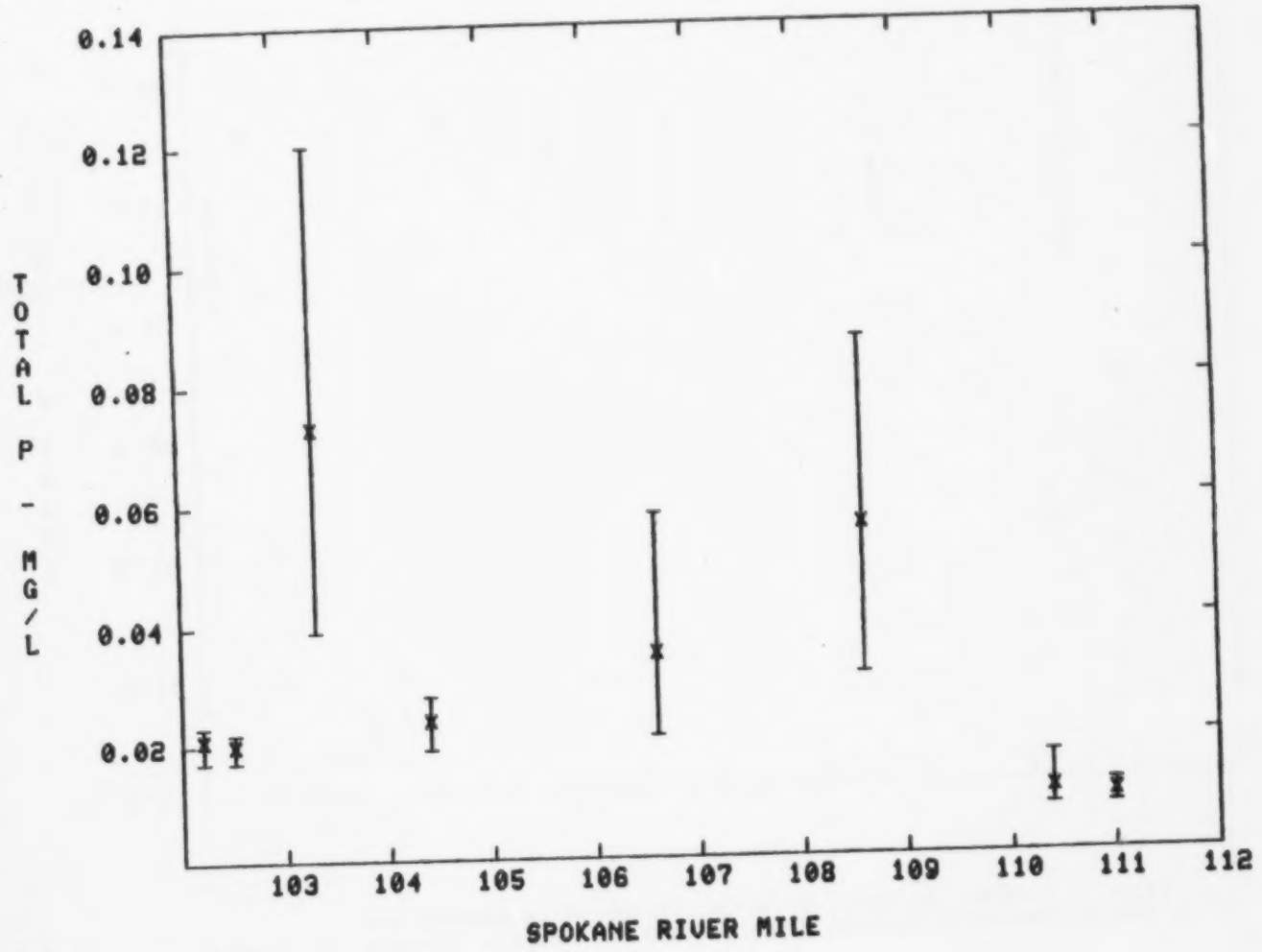


Figure 22. Average, maximum and minimum total nitrogen concentrations in the Spokane River during Survey II (July 31 - August 2, 1979).

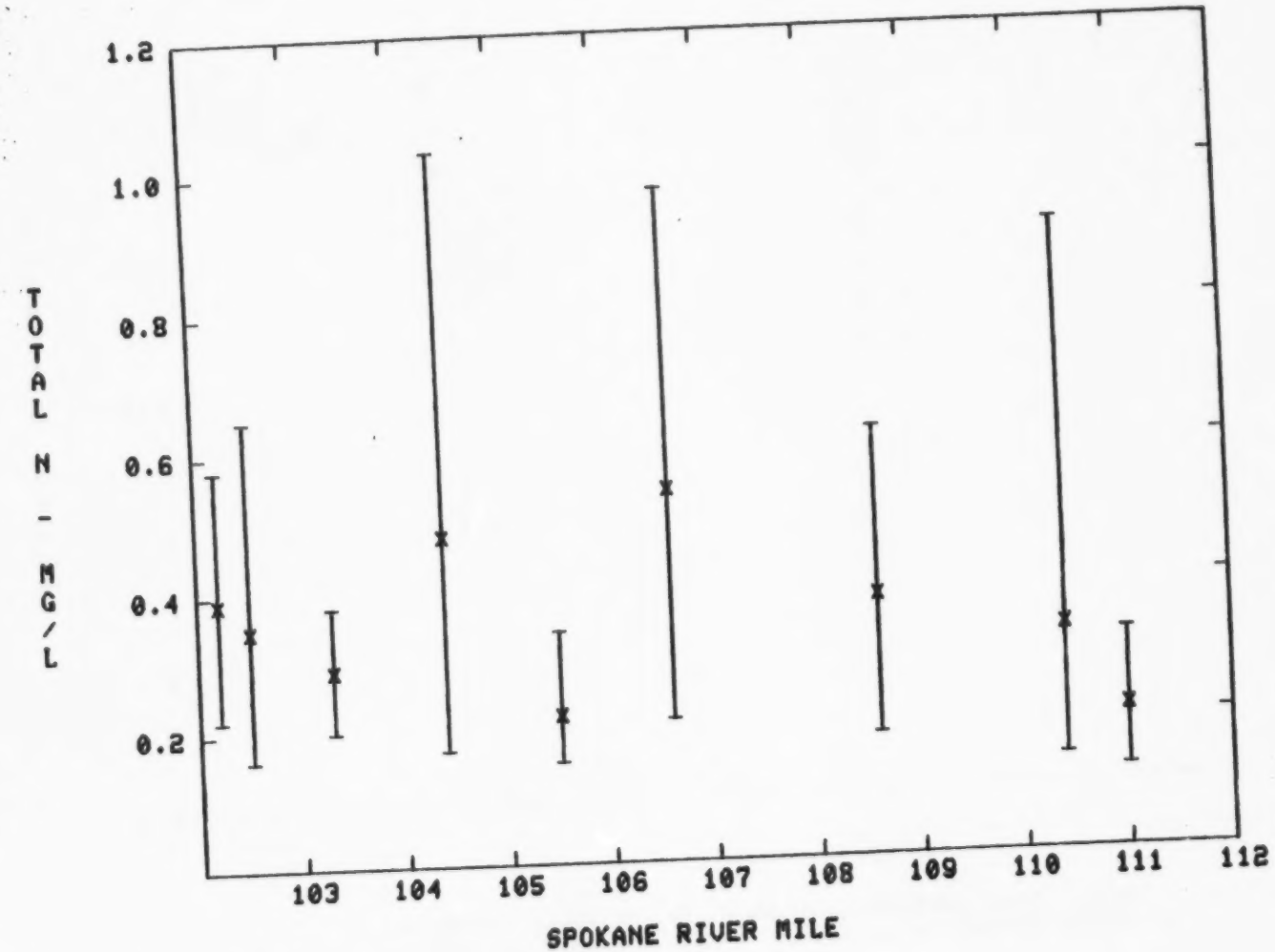


Figure 23. Average, maximum and minimum total nitrogen concentrations in the Spokane River during Survey IV (September 18-20, 1979).

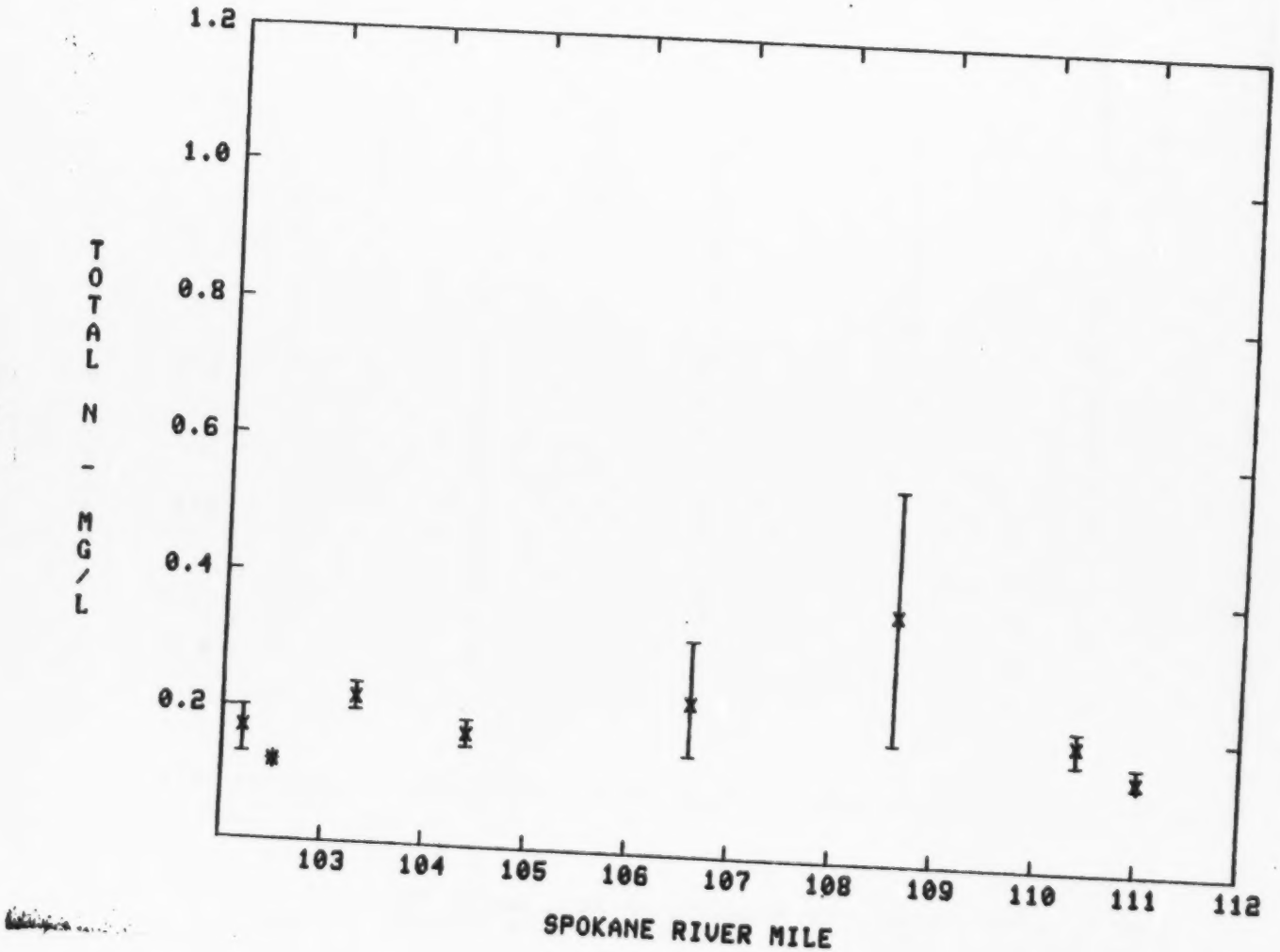


Figure 24. Average, maximum and minimum total organic carbon concentrations in the Spokane River during Survey II (July 31 - August 2, 1979).

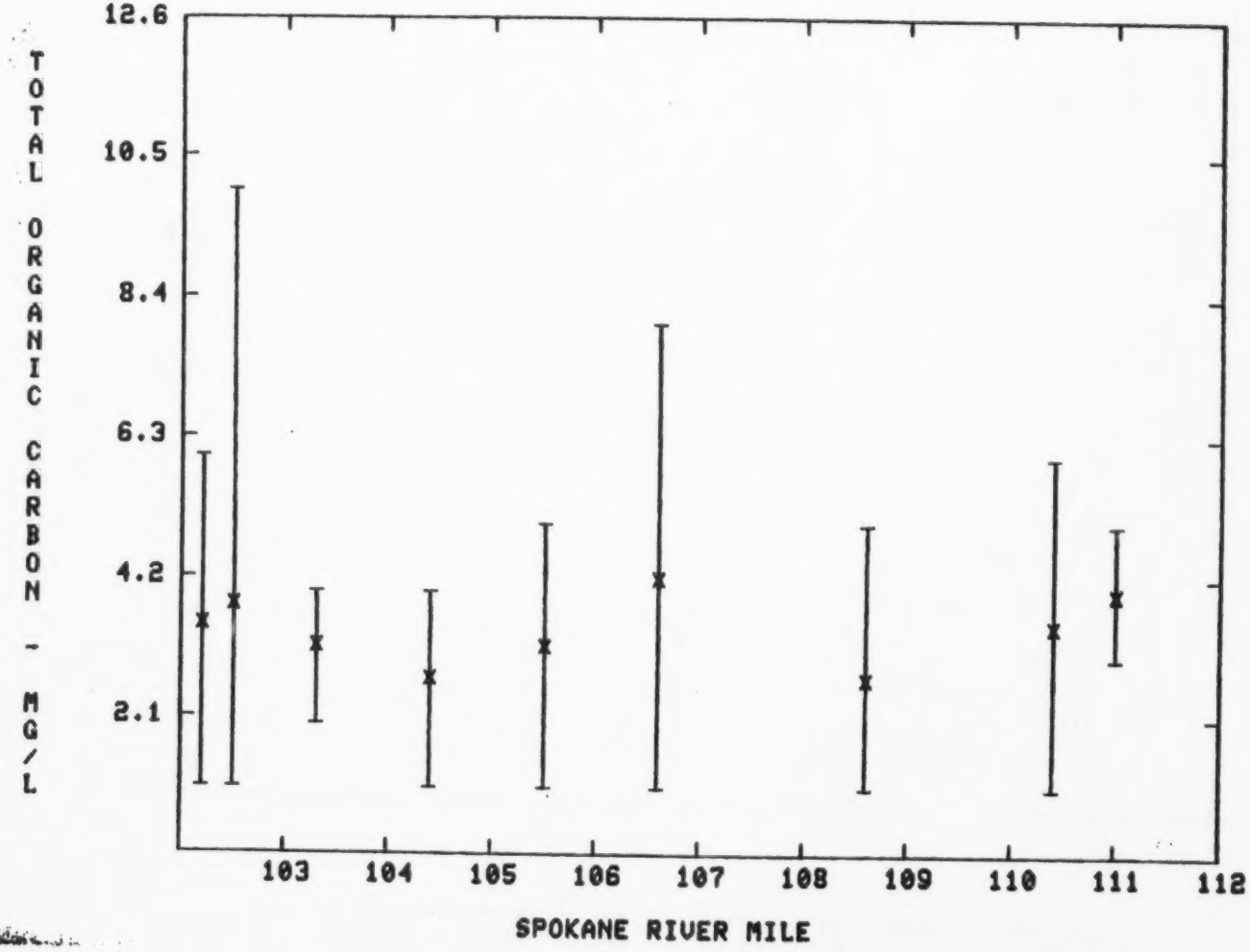
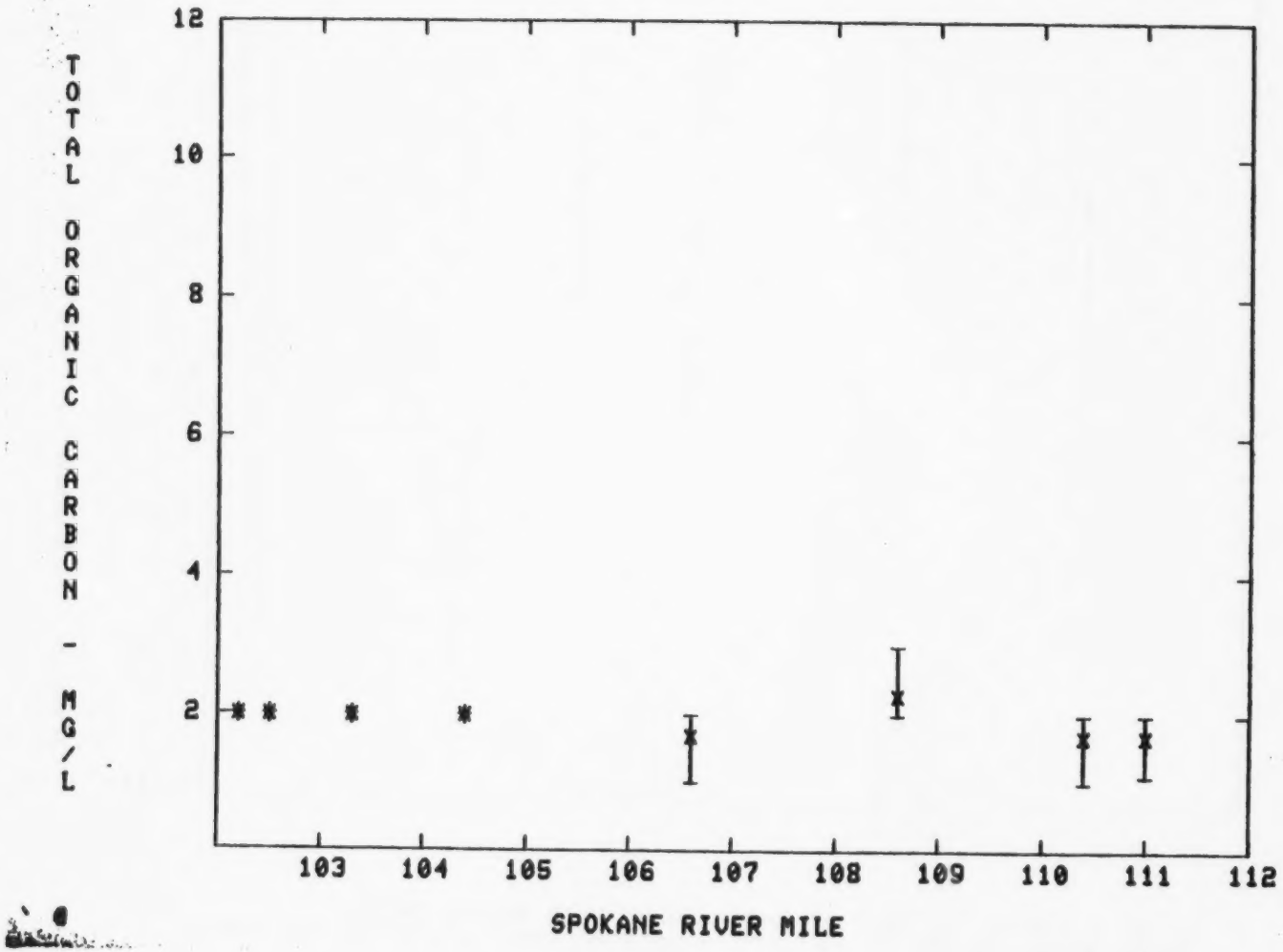


Figure 25. Average, maximum and minimum total organic carbon concentrations in the Spokane River during Survey IV (September 18-20, 1979).



Carbonaceous Biological Oxygen Demand (BOD)

Ultimate BOD and rates of deoxygenation were determined from standard, uninhibited 5-, 10-, 15-, and 20-day BOD measurements made during Surveys II (July 31-August 2, 1979) and IV (September 18-20, 1979). The results, obtained using the method of Moore et al (1950), are shown in Figures 25 and 26, and Tables 5 and 6.

Table 5 Ultimate BOD and deoxygenation rates in the Spokane River estimated from samples collected during Survey II (7/31/79-8/2/79). The method of moments (Moore et al (1950)) was used to estimate these parameters from average values of 5-, 10-, 15-, and 20-day BOD measurements

Spokane River Mile	Ultimate BOD (mg/l)	Deoxygenation Rate ($days^{-1}$, base e)
111.0	1.62	0.28
109.7	1.57	0.24
108.6	2.73	0.25
106.5	1.49	0.19
105.4	1.64	0.15
104.4	1.60	0.12
103.1	2.77	0.06
102.5	1.80	0.14
102.2	1.89	0.0[a]

Table 6 Ultimate BOD and deoxygenation rates in the Spokane River estimated from samples collected during Survey IV (9/18/79-9/20/79). The method of moments (Moore et al (1950)) was used to estimate these parameters from average values of 5-, 10-, 15-, and 20-day BOD measurements

Spokane River Mile	Ultimate BOD (mg/l)	Deoxygenation Rate ($days^{-1}$, base e)
110.0	1.56	0.16
109.7	1.98	0.09
108.6	2.11	0.12
106.5	1.88	0.13
104.4	1.93	0.07
103.1	2.02	0.08
102.2	1.37	0.13

Figure 26. Average, maximum and minimum ultimate BOD concentrations in the Spokane River during Survey II (July 31 - August 2, 1979).

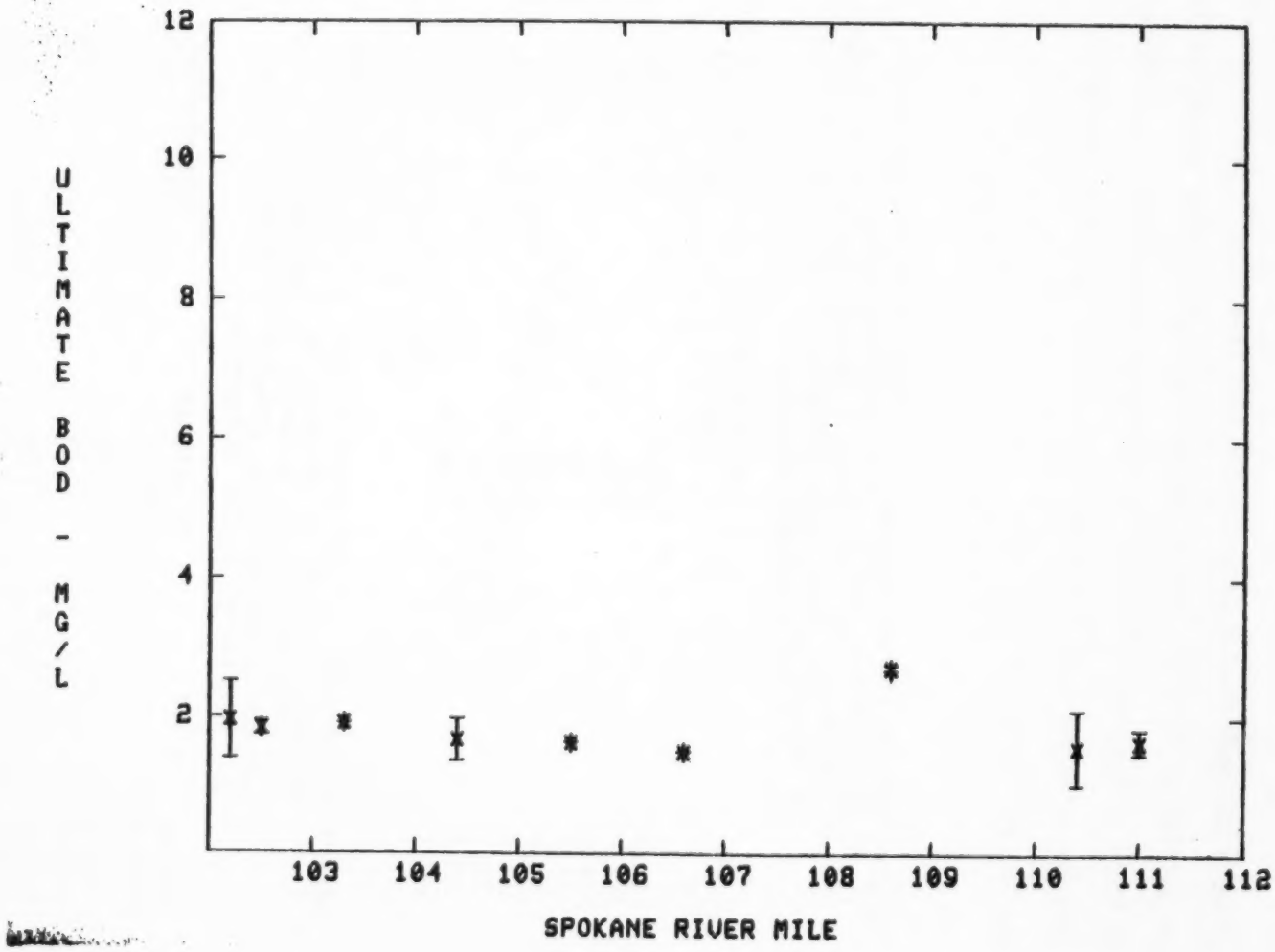
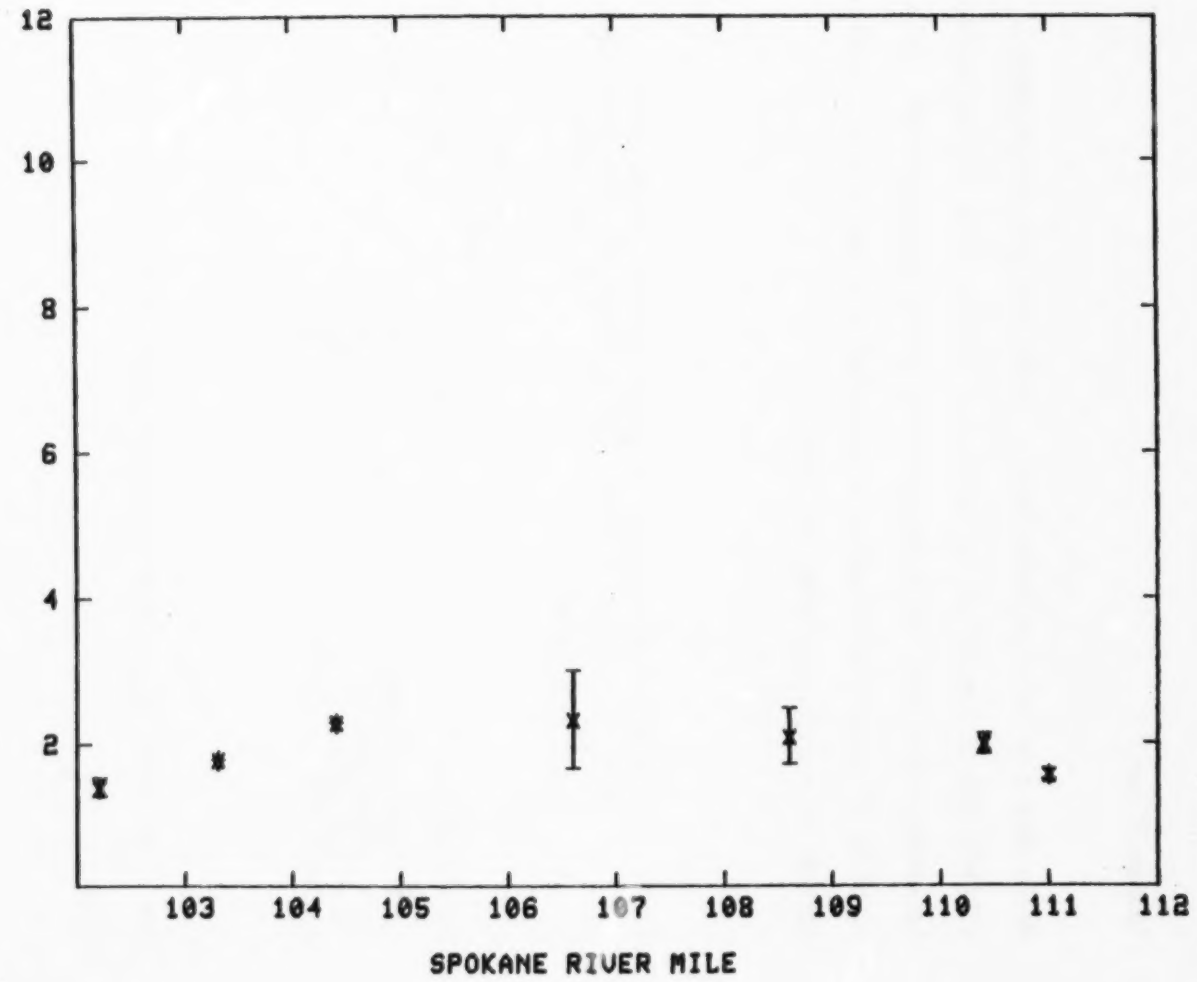


Figure 27. Average, maximum and minimum ultimate BOD concentrations in the Spokane River during Survey IV (September 18-20, 1979).



Point Sources

Spokane River

Measurements of total organic carbon, total nitrogen and phosphorus, ultimate BOD at the outlet of Lake Coeur d'Alene (R.M. 111.0) reflect the background water quality characteristics of the Spokane River. Mass loadings of these constituents, as measured at River Mile 111.0 during Surveys II and IV, are shown in Table 7.

Table 7 Estimated loading rates of total organic carbon, total phosphorus, total nitrogen and ultimate BOD from Lake Coeur d'Alene during Survey II (7/31/79-8/2/79) and Survey IV (9/18/79-9/20/79)

Constituent	Loading Rate (lbs/day) Survey II	Survey IV
Total organic carbon	17700	16200
Total phosphorus	44	81
Total nitrogen	930	1290
Ultimate BOD	7190	12600

The river flows, Q_{CDL}, used to compute these loadings were estimated from:

$$Q_{CDL} = Q_{PF} + Q_{RP} + Q_{GW}$$

Where,

Q_{PF} = the discharge of the Spokane River below Post Falls (Table 4), c.f.s.

Table 8 Concentrations and estimated loadings* of total organic carbon, total Kjeldahl nitrogen, ammonia-nitrogen, nitrite-plus nitrate-nitrogen, dissolved orthophosphate and total phosphorus for the Coeur d'Alene sewage treatment plant during Survey II (7/31/79-8/2/79) and Survey IV (9/18/79-9/20/79)

Date	Time	Type of Sample	Daily Average Flow (mgd)	TOC (mg/l)	TOC (lbs/day)	TKN (mg/l)	TKN (lbs/day)	NH_3-N (mg/l)	NH_3-N (lbs/day)	NO_2-+NO_3-N (mg/l)	NO_2-+NO_3-N (lbs/day)	PO_4-P (mg/l)	PO_4-P (lbs/day)	Total P (mg/l)	Total P (lbs/day)
Survey II															
7/30/79	1715-														
7/31/79	0930	Composite	2.06	--	--	10.2	17.6	6.5	112	6.0	103	7.6	131	7.8	134
7/31/79	0930-														
8/1/79	0955	Composite	2.12	29	514	8.6	152	6.0	106	7.4	131	7.2	128	7.8	138
8/3/79	0930	Grab	2.13	30	534	10.4	185	6.4	114	8.6	153	7.1	126	--	--
Survey IV															
9/18/79	1000	Grab	1.91	28	447	5.9	94	--		--		--		7.3	116
9/19/79	1000	Grab	1.93	24	387	6.0	97	2.6	42	13.2	213	7.0	113	7.7	124
9/20/79	0930	Grab	1.80	24	361	12.3	185	2.7	41	12.8	192	7.5	113	8.0	120

* Estimated loadings are based upon daily average flow from the sewage treatment plant

Q_{RP} = the water diverted for irrigation use in the Rathdrum Prairie Project (Table 4), c.f.s.

Q_{GW} = 150 c.f.s., the amount of water which the USGS estimates is lost to the groundwater between Coeur d'Alene and Post Falls.

City of Coeur d'Alene STP

Single grab samples, as well as 24 hour composite samples, of treated effluent were collected from the City of Coeur d'Alene's sewage treatment plant during Surveys II and IV. Concentrations and estimated loadings of total organic carbon, total Kjeldahl nitrogen, ammonia-nitrogen, nitrite-plus nitrate-nitrogen, dissolved orthophosphate and total phosphorus are given in Table 8. 5-, 10-, 15-, and 20-day BOD measurements were also obtained from these samples. However, the results of the measurements suggested that the waste contained constituents which made the BOD test unreliable. For example, as shown in Table 9, the 5-day BOD increased as the waste was diluted. Attempts at estimating deoxygenation rates for the treatment plant effluent were thwarted by the odd behavior of the BOD assays, as shown in Table 10.

Table 9 5-day BOD as a function of dilution for samples collected from the City of Coeur d'Alene sewage treatment plant on 7/31/79 and 8/1/79.

Dilution Level %	5-day BOD (mg/l) 7/31/79 Sample	8/1/79 Sample
0.5	98	268
2.5	45	47
5.0	31	27
10.0	24	18

Table 10 5-, 10-, 15-, and 20-day BOD measurements of samples collected from the City of Coeur d'Alene sewage treatment plant on 7/31/79 and 8/1/79.

Sample Date	Dilution (%)	3-day BOD (mg/l)	10-day BOD (mg/l)	15-day BOD (mg/l)	20-day BOD (mg/l)
7/31/79	2.5	45	29	74	64
8/1/79	0.5	268	130	224	58

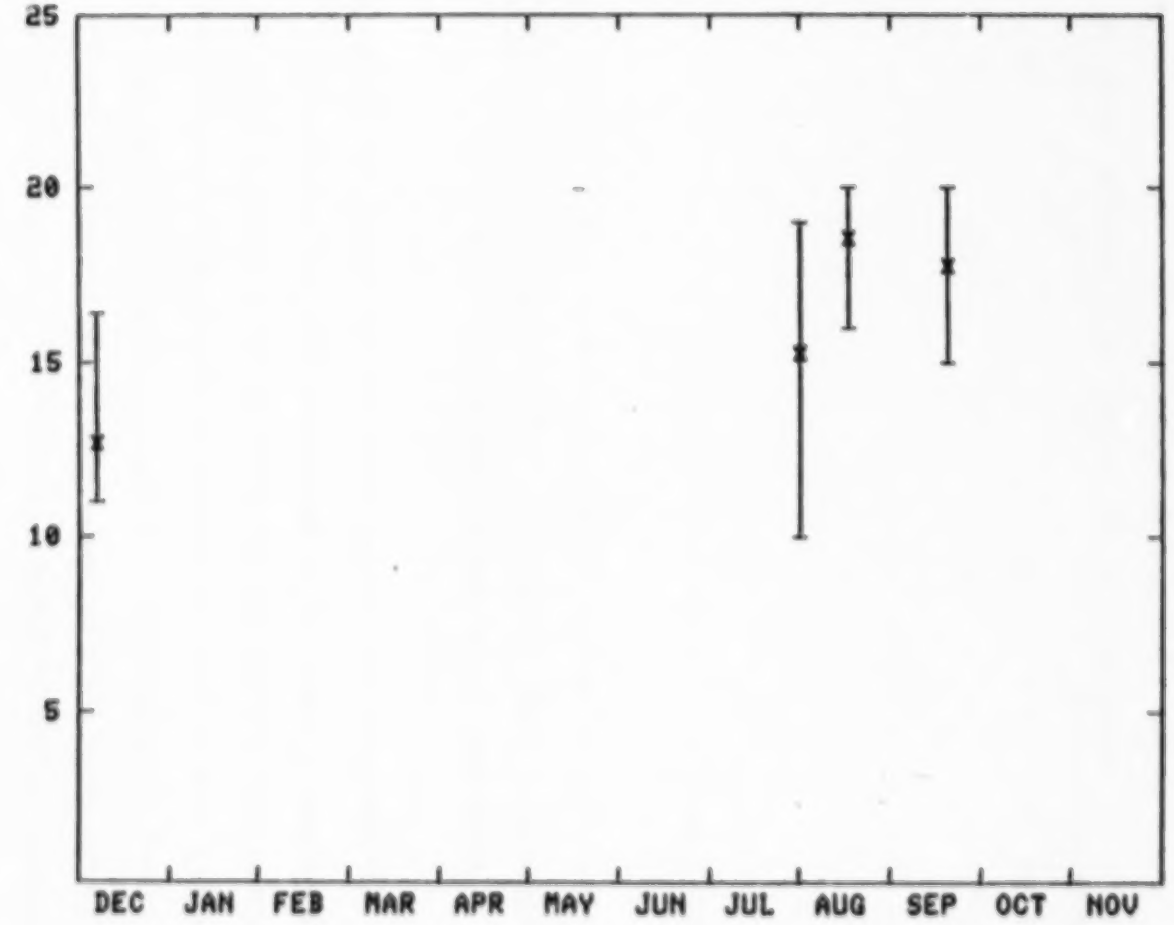
Trophic Status

Water Clarity

Water clarity, as measured by the depth at which a Secchi disk disappears, is shown in Figure 28. Data include only those stations for which water depth was greater than the Secchi disk reading.

The minimum Secchi disk reading during the four surveys was 10 feet and the maximum, 20 feet. Dillon and Rigler (1975), who compared Secchi disk readings with chlorophyll a concentrations for a number of lakes in southern Ontario, found for readings of 10 feet and greater, chlorophyll a concentrations were less than 5 ug/l. Lorenzen (1979), analyzing data collected during EPA's National Eutrophication Survey (NES) from lakes throughout the United States, found chlorophyll a concentrations were less than 10 ug/l for all lakes with readings greater than 10 feet. Given these findings, and trophic classifications based upon chlorophyll a (Chapra and Tarapchak (1976)), the Spokane River between Post Falls would be classified oligotrophic to merotrophic.

Figure 28. Water clarity in the Spokane River during Surveys I, II III and IV as measured by Secchi disk depths.



Aquatic Plants

During Survey IV we made a survey of the approximate areal extent of the aquatic plant community. We performed this survey from the boat while moving slowly along the river bank. We took no samples, and our assessment was based only upon our judgment of the relative abundance and areal extent of the plants. According to Professor Michael Falter (personal communications) of the University of Idaho, the predominant plant is a species of Equisetum (horsetail). Figure 29 shows the results of the survey.

Algal Assay

In an effort to determine the potential for algal growth in the Spokane River above Post Falls, we collected water samples for the static algal assay, as developed by Miller, Greene and Shiroyama (1978). We collected these samples during Survey IV at two locations, one at the outlet of Lake Coeur d'Alene, the other just upstream from Post Falls Dam. The sample at each of the two stations was a composite of water taken from the surface, mid-depth and bottom.

A major conclusion from the assay, according to Cummins et al (1980), was:

> "The samples of Spokane River water assayed could be considered to be only moderately productive based on a productivity classification linked to the 14-day standing crop of S. capricornutum by

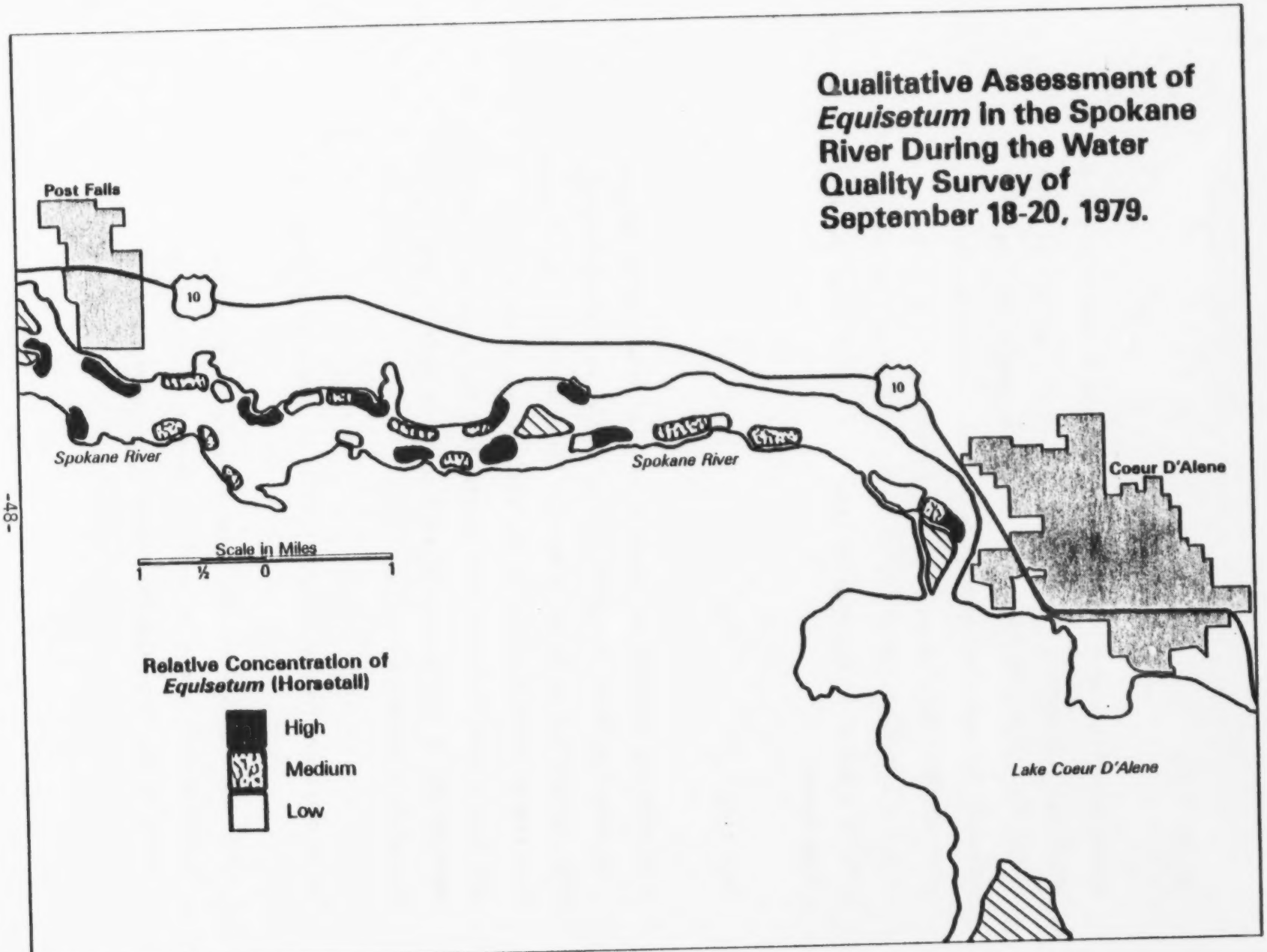

Qualitative Assessment of
Equisetum in the Spokane
River During the Water
Quality Survey of
September 18-20, 1979.
Post Falls
10
10
Spokane River
Spokane River
Coeur D'Alene
Lake Coeur D'Alene
Scale in Miles
1 ½ 0 1
Relative Concentration of
Equisetum (Horsetail)
High
Medium
Low

Figure 29

Miller, Maloney and Greene (1974). Although the addition of nitrogen alone resulted in increased algal growth during the assay, the evaluation of the effect of increased nitrogen or phosphorus concentrations on the productivity of the River itself is complicated by the possible presence of substances inhibiting algal growth."

Effects of Land and Water Use

The Spokane River between Coeur d'Alene and Post Falls is used for transportation, recreation, fishing and the generation of hydroelectric power. All of these water uses, as well as their associated riparian land use, have some impact upon the quality of the Spokane River. During our four surveys, however, it appeared the major impact, both upon the Spokane River and the land adjacent to it, was from the transportation, handling and processing of logs.

At times during all four of our surveys there were large amounts of sawdust, bark and logs floating in the river. In the vicinity of the sawmills and log handling areas, the river bank was highly disturbed. We made no attempt to measure the impacts of careless log handling practices. It is clear, though, that with respect to aesthetics and normal boat traffic the impact is substantial. The impact of the organic matter and nutrient upon water may be important, as well, and should be given consideration equal to that of the discharge of domestic wastes.

CONCLUSIONS

1. The morphology of the Spokane River's bottom, with fairly deep isolated holes at Ford Rock and behind Post Falls Dam, has substantial impact upon water quality during low flow.

2. Dissolved oxygen levels were between 81% and 90% saturation during Survey I, varied from 33% to 113% during Survey II, from 2% to 108% during Survey III, and from 86% to 101% during Survey IV. The veritical and longitudinal distribution of dissolved oxygen was fairly uniform during Surveys I and IV. During Surveys II and III when river flow was low and water temperature high, the dissolved oxygen decreased with depth, particularly below 10 meters, and with distance downstream. Vertical depression of dissolved oxygen was as much as 7.4 mg/l and average longitudinal depression as much as 2.0 mg/l.

3. Water temperature greater than 20^{o}C were common during Surveys II, III, and IV. During Survey I they varied from 4.0^{o}C to 5.1^{o}C. Temperatures were generally uniform throughout Surveys I and IV, although there was some surface heating which elevated temperatures during Survey IV. During Surveys II and III water temperature decreased with depth as much as 5.1^{o}C at Ford Rock. Surface temperature increased downstream from the outlet of Lake Coeur d'Alene as much as 1.5^{o}C during Survey II.

4. Levels of nitrogen and phosphorus were generally low throughout the Spokane River from the outlet of Lake Coeur d'Alene to Post Falls Dam. Total phosphorus, though at low levels, was substantially higher downstream from the City of Coeur d'Alene's sewage treatment plant than it was upstream.

5. Algal assays of samples collected during Survey IV showed the Spokane River to be moderately productive. The evaluation of the assay, however, was complicated by the presence of substances inhibiting algal growth.

6. Water and riparian land uses associated with the transportation, handling and processing of logs have substantial impact on other water uses. The effect on aesthetics and normal boat traffic is particularly severe. The effect upon water quality is not known but warrants further investigation.

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